City of Irvine Zero-Emission Vehicles Transition Plan

Final Report

March 2022

Revised April/May 2022

Center for Sustainable Energy®

Authors:
Demetra Tzamaras, Manager, Distributed Energy Resources
Rick Teebay, Senior Manager, Transportation
Alex Dahl, Coordinator, Transportation
Kristin Larson, Manager, Transportation
Meghna Eluganti, Senior Research Analyst, Transparency and Insights
Ben MacNeille, Analyst, Transparency and Insights
Paul Tuck, Electrical Engineer, Engineering

CSE Headquarters
Center for Sustainable Energy
3980 Sherman Street, Suite 170
San Diego, CA 92110
858-244-1177
EnergyCenter.org

Center for Sustainable Energy®

Table of Contents

Abbreviations and Acronyms

ACF	Advanced Clean Fleets
ACS	American Community Survey
AER	All-electric range
BAU	Business-as-usual (adjective)
BBB	Build Back Better
BEV	Battery electric vehicle
CA	California
CAAP	Climate Action and Adaptation Plan
CALeVIP	California Electric Vehicle Infrastructure Project
CARB	California Air Resources Board
CCFR	California Clean Fuel Reward Program
CEC	California Energy Commission
CLEEN	California Lending for Energy and Environmental Needs
CMS	Clean Miles Standard Program
CNG	Compressed natural gas
CP	ChargePoint
CVC	California Vehicle Code
CVRP	Clean Vehicle Rebate Project
DAC	Disadvantaged community
DCFC	Direct current fast charging
EnergIIZE	Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles
EVI	Electric vehicle infrastructure
EVSE	Electric vehicle supply equipment

FCEV	Fuel cell electric vehicle
FTC	Federal tax credit
FY	Fiscal year
GHG	Greenhouse gas
GRV	Guaranteed residual value
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
ICT	Innovative Clean Transit
L1	Level 1 charger
L2	Level 2 charger
LCFS	Low Carbon Fuel Standard
NG	Natural gas
NOx	Nitrogen oxides
OSF	Operations support facility
PHEV	Plug-in hybrid electric vehicle
RNG	Renewable natural gas
SCE	Southern California Edison
SOC	State of charge
TAZ	Traffic Analysis Zone
VMT	Vehicle miles traveled
ZEV	Zero-emission vehicle

I. Introduction

The City of Irvine, a historically proactive municipality in terms of energy planning, is working to achieve carbon neutrality by reducing and balancing its carbon emissions with carbon savings. To meet this goal and contribute to California's broader goal of reaching carbon neutrality throughout the state by 2045, the city organized its own Community Choice Energy initiative and localized Strategic Energy Plan. The Strategic Energy Plan reported that transportation accounted for 26% of communitywide energy consumption and generated 33% of the city's greenhouse gas (GHG) emissions. Even more recently, Ascent Environmental's 2019 GHG inventory --- completed as part of the development of the broader Climate Action and Adaptation Plan (CAAP) for which this fleet analysis is a part of --- found that communitywide, transportation represented 51% of Irvine communitywide GHG emissions. Adopting clean vehicle technology is a highly effective strategy to reduce emissions from transportation.

Per the Strategic Energy Plan, the city's transition to zero-emission vehicles (ZEVs) will not only reduce GHG emissions but will also reduce city operational and maintenance costs, improve air quality, reduce noise pollution, and create health benefits for residents. The Strategic Energy Plan outlines several transportation and land use recommendations, the first of which (TLU-1) being reducing emissions from city fleet vehicles. **This plan aligns with the first step of this recommendation: establishing a plan by 2022 to transition all city-owned light-duty fleet vehicles to zero-emission vehicles by 2032. This plan also aligns with a part of TLU-3.1: [create] an infrastructure plan for public and private electric vehicle supply equipment (EVSE) needs citywide.**

Additionally, since the adoption of the Strategic Energy Plan, there are several new state policies and regulations that will be considered for this plan. Following Governor Gavin Newsom's 2020 Executive Order (N-79-20) mandating that all light-duty vehicle sales be ZEVs by 2035 and all bus and truck sales be ZEVs by 2045, the California Air Resources Board (CARB) is currently workshopping an implementation plan via the Advanced Clean Fleets regulation. This proposal would require that starting in 2024, 50% of public fleets' new or replacement vehicle purchases be zero emission, followed by 100% of purchases starting 2027. Beginning in 2023, if the proposed Advanced Clean Fleets regulation is adopted, **the city will be required to phase in the purchase of ZEVs and will need to purchase at least half of its non-California Vehicle Code (CVC) 165 trucks, vans, and shuttles as ZEVs beginning in 2024 and 100% of these vehicles beginning in 2027.**

Over the next 10 years, the city will transform its fleet from petroleum-fueled vehicles to ZEVs, install city facility ZEV infrastructure, and work to encourage public ZEV infrastructure in its communities of most need to meet these overarching goals, policies, and regulations. This plan outlines how the city can begin to transition its fleet in the near term, midterm, and long term, as well as construct the infrastructure needed to support this transition. The plan also assesses the wider Irvine community and makes recommendations on areas of focus for electric vehicle (EV) adoption and electric vehicle infrastructure (EVI) development.

For the purposes of this plan, transition phases are defined as follows:

- Near term is defined as prior to fiscal year (FY) 2024-25
- Midterm is defined as FY 2025-27
- Long term is defined as FY 2027-30 and beyond

II. Legislative Context

State ZEV Goals and Regulations

Along with the Advanced Clean Fleets proposal, there are several state legislative actions, goals, and regulations that the City of Irvine should consider when implementing this plan. AB 32 requires that the state and its political subdivisions reduce carbon emissions by 80% from their 1990 levels by 2050. SB 350 requires that the state reduce its carbon emissions by 50% from their 1990 levels by 2030. Transportation is the single largest source of NOx, PM, and GHG emissions. The state cannot achieve significant emissions reductions without transitioning to zero-emission vehicles. The state's aggressive air quality and climate targets include a reduction GHGs of 40% below 1990 levels by 2030, an 80% reduction below 1990 levels by 2050, and a 50% reduction of petroleum use by 2030 (CARB, 2021). In California, the transportation sector accounts for 50% of GHG emissions and more than 90% of toxic diesel particulate matter emissions (CEC, 2019).

In addition, California became the first state in the nation to enact a phaseout the sale of new gas-powered vehicles by 2035, which is expected to result in a 35% reduction of GHGs and an 80% reduction in nitrogen oxides (California, Office of the Governor, 2020). This means a shift to low- or zero-emission vehicles, meaning no GHG emissions are emitted from the vehicle tailpipe. This transition is also anticipated to yield a two to five times increase in energy efficiency and greatly reduce indirect GHG emissions (CARB, 2021). California's ZEV Program includes tailpipe regulations and limits on auto manufacturers' sale of gasoline-powered vehicles to limit smog and GHG emissions. Currently ZEV technology includes full battery electric, hydrogen fuel cell, and plug-in hybrid-electric vehicles (CARB). CARB's ZEV regulations do not recognize natural gas (NG) or propane vehicles, even those with newer "near-zero" engines and running on renewable natural gas (RNG), as zero-emission vehicles.

Under existing CARB regulations and pending fleet regulations, only the vehicles below qualify as ZEVs:

- Plug-in hybrid electric vehicles (PHEVs) with a (to be determined) minimum all-electric range.
- Full battery electric vehicles (BEVs) such as Teslas, Chevrolet Bolt EV and EUV, etc.
- Hydrogen fuel cell electric vehicles (FCEVs), like the Toyota Mirai or the Hyundai Nexo.

California Air Resources Board (CARB) Regulations

The California Air Resources Board (CARB), the agency responsible for reducing statewide GHG emissions, enforces the long-term goal of transitioning the transportation sector to zero-emission vehicles. This plan complies with CARB regulation requirements.

Federal Clean Air Act

The 1970 federal Clean Air Act created the U.S. Environmental Protection Agency (EPA) and gave the EPA the regulatory responsibility and authority to set federal emissions standards. The Clean Air Act recognized the State of California's decades of leadership and specifically allows CARB to set stricter emission standards if the state could demonstrate that the emissions created harm and if the stricter standards reduced that harm. CARB must seek a waiver from the EPA for its stricter emission standards.

The other 49 states can adopt either federal or California's emissions standards. Fourteen states and the District of Columbia have adopted California emissions standards in many areas. Recently, five states including Oregon, Washington, Massachusetts, New York, and New Jersey have adopted CARB's Advanced Clean Truck regulation cited below.

California Executive Order B-16-2012 and 2016 ZEV Action Plan

In 2012, Governor Jerry Brown issued Executive Order No B-16-2012 requiring state agencies to purchase at least 10% of their new and replacement light-duty vehicles as ZEVs by 2016 and 25% of the new and replacement vehicles as ZEVs by 2020. Four years later, the Governor's 2016 ZEV Action Plan expanded the requirement by 5% per year through 2025, resulting in 25% of light-duty vehicles in FY 2019-20, increasing to 50% of light-duty vehicles in FY 2024-25.

Advanced Clean Cars Program

In 2012, the California Air Resources Board adopted its Advanced Clean Cars Program. The program goal is to reduce GHGs, NOx, and PM emissions. It established emission standards for future years. The emission standards include CO2 standards. The program includes CARB's ZEV Program.

Zero-Emission Vehicle Program

The CARB ZEV Program requires light-duty vehicle manufacturers to produce and sell an increasing percentage of ZEVs over a period of model years. Manufacturers can receive extra credits for sales that exceed the requirements and for sales in the early years of the program. Credits can be traded or sold to other manufacturers.

Clean Miles Standard Program

The recently adopted Clean Miles Standard Program (CMS) aims to reduce emissions specifically in transportation network companies such as Uber and Lyft by enforcing GHG emissions reduction targets that these passenger ride-hailing services are required to meet. This regulation was adopted in May 2021 and incorporates many strategies for reducing emission reduction targets, such as electrification of vehicles, increasing vehicle occupancy, and encouraging connections to existing transit. CMS ensures that transportation network company drivers will need to purchase electric vehicles and that there are charging stations available to them.

Advanced Clean Fleets

CARB has been workshopping an Advanced Clean Fleets (ACF) regulation that will require that all fleets of 50 vehicles or more purchase at least half of their new and replacement medium-duty and heavy-duty vehicles (Class 2 through Class 8) as ZEVs beginning January 1, 2024. This CARB requirement increases to 100% of new and replacement vehicles beginning January 1, 2027. Emergency vehicles driven by sworn officers, as defined by California Vehicle Code 165 (CVC 165) would be exempt from the ACF. While CARB has not yet adopted the ACF, it complements, the Advanced Clean Trucks regulation, adopted in 2020. The ACF is expected to be in place after the current workshopping period is complete.

Beyond the Regulations

It is important to note that although regulations and legislation are influential means of promoting ZEV adoption, they are not the sole drivers and may not encourage the fastest changes in industry. Regulations are intended to spur the market forward; however, accelerated adoption of new technologies may cause the industry to achieve vehicle transition goals earlier than required by legislation and regulations. Many changes are coming to transportation that will impact adoption timelines, including increasing manufacturing capacity and the availability of lower-cost batteries and battery packs. The cost of a battery pack is a major cost driver for ZEVs. As costs to produce battery packs continue to decline, the cost of ZEVs will decrease as well, making them more competitive with combustion engine vehicles. At CES 2022, Mary Barra, CEO of GM, said that by 2024, battery costs will be about half of what they are today.

Ford has indicated that it will be capable of producing as many as 600,000 ZEVs by 2023. GM will have capacity for as many as one million vehicles by 2024. GM has stated that its newest batteries will lower their battery costs by as much as 50% by model year 2024. Many auto manufacturers and their battery suppliers are building new U.S. production facilities. Ford is partnering with SK, GM is partnering with LG Chem, and Volkswagen is partnering with CATL. Another anticipated factor is the shift to commercial solid-state batteries, which have much greater energy density and the potential to greatly reduce charging times while also offering greater safety than volatile lithium-ion batteries because of the replacement of flammable liquid electrolytes. Both Toyota and Volkswagen have announced their intention to switch to these batteries when they become available (currently 2023). Tesla produced and sold more than 900,000 vehicles in calendar year 2021. Its facility in Fremont California produced more than 470,000 vehicles. Its new facility in China produced 70,000 vehicles in December of 2021 and is now capable of producing more than 800,000 vehicles per year. Tesla is also opening new plants in Germany and Texas in calendar year 2022.

III. Zero-Emission Vehicle (ZEV) Technologies

Currently, CARB recognizes three technologies as ZEVs: battery electric (BEVs), plug-in electric hybrids (PHEVs) with a minimum all-electric range (AER), and hydrogen fuel cell (FCEV). City of Irvine should focus on full battery electric into FY 2027 and then hydrogen fuel cell technologies in the years beyond. This section will provide an overview of electric and hydrogen vehicle technologies, including existing models and applicability, as well as infrastructure considerations for each technology. It is important to note that beyond this background section, the bulk of this report focuses solely on BEVs and their charging infrastructure because of the increasing availability and decreasing costs.

Hydrogen

Vehicles

Hydrogen is often considered the "other" zero-emission fuel, and at this time, the adoption of hydrogen trails the adoption of electric vehicles by a wide margin. There are a limited number of FCEVs available. Beginning as a 2017 model, Honda produced the Clarity as a limited range battery electric, a fuel cell, and a PHEV. Honda discontinued production of the battery electric version in 2019, and in June 2021, Honda announced that it was discontinuing its remaining Clarity Fuel Cell and the PHEV models. In 2021, Toyota released an updated and larger second-generation Mirai, and Hyundai continues to offer its Nexo Fuel Cell SUV. Pricing for the Mirai and Nexo start at almost $60,000. The first generation Mirai was on state contract for $41,000 and included up to $15,000 for three years of fuel. Both the second generation Mirai and the Nexo can be leased.

The most common application for fuel cell (FC) vehicles has been larger transit buses, especially where range is an issue. FC buses currently provide a significantly greater range than battery electric buses in this application. Hydrogen is better suited for larger vehicles, Class 7 and Class 8 trucks and buses that travel longer distances and need a 300-mile range. The hydrogen tanks, like NG tanks, take up a lot of space — much of the trunk space in a light-duty vehicle and many mid-sized commercial trucks, Class 2 to Class 6 are typically weight sensitive, so the size and additional weight of hydrogen tanks is prohibitive. However, transit buses have already accommodated NG tanks, so it may be easier to replace the NG buses with hydrogen buses. FC powered buses are gaining traction among transit agencies including Orange County Transit Authority, Sunline Transit in Palm Springs, Foothill Transit, and AC Transit in the Bay Area. Transit agencies that were transitioning to NG may be better positioned to transition to hydrogen because hydrogen vehicles require many of the same shop modifications. Many transit agencies have already made the pivot from diesel and have made facility modifications. These agencies can easily leverage their shop modifications for FC buses.

Another developing hydrogen FC application is in Class 8 tractors, such as the drayage trucks servicing ports. Toyota is building 28 Class 8 tractors in the coming year as part of a demonstration project. Toyota partnered with Kenworth to pilot several Class 8 fuel cell tractors in the ports of Los Angeles and Long Beach. Toyota will be bringing in 28 fuel cell-powered Hino Class 8 tractors for the drayage industry to Southern California in 2022-23.

Infrastructure

Hydrogen fueling infrastructure has been challenging on a several levels.

The source of the feedstock of hydrogen is a limiting factor to widespread adoption. In the past, hydrogen was derived from NG, where NG is passed through a reformer that separates the hydrogen. CEC-funded hydrogen stations require that at least 40% of hydrogen be from renewable sources. Renewable sources include methane captured from anerobic digesters, sewage treatment plants, landfills, dairies, etc. Another renewable source of hydrogen is through electrolysis from either solar or wind. Most hydrogen is not produced on site and must be trucked in as petroleum products are today.

At stations, hydrogen is stored as either a liquid (cryogenic) or as a gas. Hydrogen, like NG, is typically stored on the vehicle as a gas. Hydrogen gas is stored at 7 millibars or 10,000 PSI, a pressure about three times higher than NG, about 10,000 psi compared to about 3,200 to 3,600 psi, respectively. Like NG, hydrogen requires additional facility modifications for safety. NG and hydrogen are gases stored under significant pressure. Because both are lighter than air, if there is even a small leak, these gases rise. Any spark can trigger an explosion. If the vehicles are worked on in the shop, or stored indoors overnight, there must be automatic garage door openers, an air extraction system, a methane detection system, explosion proof electrical, etc.

Unlike electric vehicles, FCEVs cannot currently be refueled at home. The cost to install a public hydrogen station has been declining in recent years; however, the cost to install a new hydrogen station can still be expensive. A limited volume commercial station capable of refueling several passenger vehicles per day, currently costs about $1 million to $1.5 million. Larger stations capable of refueling 10 to 50 commercial vehicles, such as transit buses, currently costs about $10 million to $12 million. Commercial stations are suitable and may make more sense if a sufficient or large number of medium- and heavy-duty fleet vehicles are at a given site. The cost of refueling infrastructure for a significant number of FC buses is very competitive with the cost of an appropriate number of high-powered DCFC required for battery electric buses. For example, a refuse firm or a transit operator may find it more cost effective to spend $10 million to $11 million for a hydrogen station to refuel 30 to 40 vehicles vs. the cost of installing charging for the same number of vehicles. Hydrogen fueled vehicles also have a significantly longer range than similar current generation electric vehicles. Commercial hydrogen does not require enroute refueling stations. This provides more flexibility in locating refueling stations.

Fortunately, the City of Irvine is adjacent to a FCEV fueling station at the University of California Irvine. UC Irvine is very accomplished in hydrogen energy as demonstrated by its hydrogen station, which has been open for almost 20 years. While demonstrating the potential for sustainable transportation fueling, the station was the first dual-pressure station in the nation with public fueling access. The purpose of the hydrogen station is not just to fuel its hydrogen buses, but also to promote green NG research and to provide an opportunity for public retail sales. The UC Irvine hydrogen station typically disperses 250 kilograms or more per day, even though it was originally designed to disperse 180kg/day (Mobile Source Air Pollution Reduction Review Committee (MSRC), 2019). The fueling station is expected to undergo an expansion project, and UCI's upgraded site will be able to accommodate as many as 240 light-duty vehicles.

Electric

Vehicles

This report focuses on the two zero-emission vehicle types the City of Irvine should consider: BEVs and PHEVS. PHEVS are not true ZEVs, have a limited AER of 25 to 45 miles, and require daily charging. Gasoline is also used in these vehicles to allow for driving longer ranges. BEVs, like the Chevrolet Bolt, the Hyundai IONIQ 5, Kia EV-6, or Teslas, have an AER of 220 to more than 300 miles and do not have the option for gasoline power. Using 70% of the vehicle's range, BEVs have a usable range of at least 150 to 210 miles. There are a significant number and variety of BEV sedans and SUVs currently available or that will be available within the next 12 months, and the city will have a wide range of options. As half-ton pickups and vans, like the Ford F-150 Lightning and Transit 150e – 350e, become available from Ford, GM, Tesla, and others, the city will have an expanded range of choices. Within the past year, sales of electric vehicles have more than doubled, and the energy density of batteries has steadily increased. In terms of cost, as production volumes have increased, the cost per unit and per battery pack has declined.

The city can anticipate that trucks and vans will have larger capacity battery packs in the coming years, and these battery packs will remain about the same size and same weight as today's battery packs. In 2011, Nissan introduced its LEAF. The LEAF had a 24-kWh battery pack and a range of 73 miles on a full charge. Today's 2021 Nissan LEAF is built on the same platform as the original 2011 model. The 2021 LEAF e+ is available with a 62-kWh battery pack with a range of 226 miles. The 2021 LEAF's battery pack fits in the same envelope as the original 2011 battery pack, but it is ¾ of an inch taller and is about 30 lbs. heavier. And today's 62-kWh battery costs less than the original 24-kWh battery pack. Also, many manufacturers (Toyota, Volkswagen, Mercedes, Freightliner, Volvo, etc.) are working with their suppliers to develop next generation solid state batteries that will be capable of much greater energy density and withstand much higher charge rates and faster charging.

Because of the market shift to BEV vehicles, their increase in AER, and their zero-emissions benefits, PHEVS should only be purchased in the near term, if at all. As the city's EV infrastructure develops and the cost of BEVs declines, the city should anticipate purchasing predominantly BEVs beginning in the midterm, i.e., by the 2024 model year. If the infrastructure is in place sooner, the city can start immediately with BEVs in the near-term.

Infrastructure

There are three types of standard Charging infrastructure for electric vehicles: Level 1, Level 2 and Level 3 or direct current fast charging (DCFC). Additional charging technologies, such as wireless inductive charging and very high-speed megawatt charging are in development.

Level 1 and Level 2 Charging

Level 1 and Level 2 charging are used for both home and public charging. Level 1 chargers are the standard, 120-volt wall outlets, and they are the slowest charge level. Level 1 chargers typically provide only about 1.2 kW of power/hour or about 4 to 5 miles of range per hour. And it can take several days to recharge a Chevrolet Bolt with a 60-kWh battery using Level 1.

Level 2 is the typical EV plug found at public charging stations. For the past decade, the standard light-duty level 2 (L2) electric vehicle supply equipment (EVSE) has been a 30-32 amp (6.6 to 7.7 kW). Typically, each plug has been on its own 40-amp, 220v circuit. Level 2 chargers take about 4 to 10 hours to fully charge a depleted battery, depending on the size of the vehicle's battery and its State of Charge (SoC). Level 2 EVSE charge at the same rate for almost the entire charging session. They may begin charging at 7.2 kW and will charge at that rate until the battery pack is almost completely full.

In recent years, some EVSE manufacturers have offered "shared" L2 chargers to optimize load and reduce charging and infrastructure costs. A shared L2 provides two plugs, each capable of charging at 7.2 kW. These shared L2s reduce the size and/or number of transformers and electrical panels, reducing the cost of materials for an installation. The two plugs share the same 40-amp circuit breaker. When one vehicle plugs in, it will charge at up to 7.2 kW. If a second vehicle plugs in, the charger will split or share the charging to 3.6 kW to each vehicle. Shared circuits may work well for plug-in hybrids or some early, limited range (less than 100 miles) battery electrics with small capacity battery packs, vehicles that are driven less than 30 miles per day, and/or vehicles with very long dwell times. However, it is important to note that shared L2s will not be an adequate solution for today's and tomorrow's longer range ZEVs with larger batteries.

Level 3, AKA Direct Current Fast Charging

Direct current fast chargers (DCFC) will be needed to maintain critical vehicle availability and are the fastest charging option. DCFC are available in a variety of power outputs (currently 20kW-350kW). Lower output 20-kW and 25-kW DCFC are the most affordable options, ranging from $5,000 to $12,000 for the equipment. These are available as either three phase 208V or 480V. Some of the newer and smaller DCFC are capable of bidirectional charging, meaning they are capable of exporting power to a building or facility if the building is properly equipped.

A DCFC begins charging at the highest rate that the vehicle will accept and then tapers as the battery becomes charged. Some DCFC permit power sharing — allowing two vehicles to charge at the same time. This can work well when the charging of the vehicles is staggered — such as when one vehicle begins charging 15 minutes after the other. The ability to charge two vehicles at higher rates can increase the value of the DCFC.

Future Charging Developments

Wireless technology is still being developed and will be offered first in higher-end cars and SUVs. While wireless inductive charging is not recommended in this report, the city should monitor this technology as it develops in the future. Standards for wireless inductive EV charging components are still in development, and wireless charging is not currently available. Both Mercedes and Hyundia/Kia are expected to introduce new vehicles and equipment with wireless charging in addition to conventional charging ports within the coming years. There will also be additional installation costs for the wireless charging hardware (the "puck"). There is an energy loss in all charging equipment. In early wireless systems, that loss was 20% to 30%. In current systems, the energy loss is in the 7% to 10% range.

Generally, the narrower the gap between the vehicle and charging puck, the more efficient the energy transfer. It will be important that the energy pucks on or within the surface and the devices on the vehicles be uniform and within a uniform distance. This will be much easier if all the vehicles are the same and their loading is the same, for example, if the city had 10 identical Chevrolet Bolts or 20 identical Ford F-150 Lightnings. Maintaining the gap between the puck and the vehicle may be more difficult when there is a variety of sedans, trucks, and SUVs and/or vehicles that are not loaded uniformly. CharIN is a global consortium working on next generation charging infrastructure with charging rates of 1.1 MW-3.3 MW for commercial Class 8 trucks and buses.

IV. Existing Conditions

City Fleet

The Center for Sustainable Energy (CSE) began the fleet analysis by requesting an inventory of the city's existing, active fleet. To better understand the condition and existing replacement cycles of the city fleet, CSE requested a variety of data for each vehicle including the make and model, class and vocation, age, department, annual mileage or usage (in hours), fuel use, purchase cost, and parking location. Vehicles were classified by type, sedan, SUV, pickup, TRIPs shuttles, etc., and by weight classification.

The city currently has 528 cars, vans, trucks, motorcycles, carts, generators, trailers, and other movable/wheeled equipment in their fleet listing (Table 1). Equipment, such as air compressors, trailers, and generators, are included in grey in the table. Most of the city fleet belongs to the Public Safety (40%) and Public Works (31%) departments.

The following are the key highlights of the city's fleet:

- There are 261 light-duty vehicles (50%), 95 medium-/heavy-duty vehicles (18%), 41 carts (8%), and 172 generators, trailers, tanks, and other equipment (24%).
- Most of the city vehicles are gasoline powered.
- There are just 23 diesel-powered units, and the five on-road vehicles are CVC 165 assigned to Public Safety.
- The fleet includes 52 renewable natural gas powered (RNG) vehicles, two electric ZEVs and 15 electric carts. Of the 52 RNG vehicles, 23 are F-150 pick-up trucks (44%) and nine are F-250 pick-up trucks (17%).
- The remainder of the RNG vehicles are a combination of TRIPs shuttles, 15-passenger vans, and nine Classes 6 through Class 8 trucks.

Note that conventional NG, like gasoline and diesel, is a fossil fuel extracted from the ground. NG has a lower carbon intensity compared to other fossil fuels and is an alternative for gasoline, made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure.[21] However, as noted above in the technologies section, CARB does not recognize RNG-powered vehicles as ZEVs, even the newer NG units with near-zero emission engines. RNG vehicles are currently viewed as a bridge while the city's fleet transitions to true ZEV technologies.

The majority of the city's vehicles are used locally in areas in and around the city. The fleet is well suited for electrification because most of the city's vehicles are used between 30 and 60 miles per day — well within the usage range of existing PHEVs or 200+ mile BEVs. Based upon their usage, PHEVs will need to be recharged daily. Most BEVs will need to be charged once every two to four days. Even the city's highest use vehicles, like the trucks used by the athletics program or the TRIPs shuttles, are solid candidates with daily charging. It is worth noting that an exception to this are the patrol vehicles, which typically drive closer to 100 miles a day, but these vehicles are exempt from the ZEV regulations. A detailed spreadsheet of the city's existing fleet list is included in Appendix A, and Table 1 below provides a summary of the fleet broken down by vehicle type and across city departments. Note that the values in parentheses in the Public Safety column indicate the number of that type of vehicle that fall under emergency vehicle classification, California Vehicle Code 165, which will be discussed later in this report.

Table 1. Number of Existing Vehicles in City's Fleet by Vehicle Type and Department

Vehicle	City Manager/City Council	Community Development	Community Services	Public Safety (vehicles subject to CVC 165)*	Public Works	Total
Air Compressor			1			**1**
Large and Small Equipment			3		20	**23**
Generator			1	1	3	**5**
Trailer			16	14	21	**51**
UD (Diesel Equipment)					1	**1**
Car - Compact		5		2 (2)	1	**8**
Car – Full Size		2		11(9)	8	**21**
Cart/Golf Cart			35	4	5	**44**
Mobile Command Center				2 (2)		**2**
Dump Truck					1	**1**
Investigation				1 (1)		**1**
Motorcycle				22 (22)		**22**
Police Patrol				3 (3)		**3**
Specialty Truck			1		13	**14**
SUV – Compact		2		9 (5)	2	**13**
SUV – Full Size		1		100 (85)	4	**105**
SWAT				2 (2)		**2**
Sweeper					3	**3**
TRIPs Shuttle			6			**6**
Tractor			2			**2**
Truck – Aerial					5	**5**
Truck – Compact		1	3	5 (1)	20	**29**
Truck – Full Size	1	29	4	21 (13)	47	**102**
Vactor					1	**1**
Van – Compact		1	11		6	**18**
Van – Midsize			3	7 (6)	2	**12**
Van – Specialty			22	9 (1)	1	**32**
Total	**1**	**41**	**109**	**213 (152)**	**164**	**528**

*(X) indicates the number of vehicles, out of the total for that vehicle type, subject to CVC 165. For example, 2 (2) indicates a vehicle category where there are two vehicles in that vehicle type and both are subject to CVC 165.

The city's fleet is on a two-year replacement and is dictated by their Replacement Policy and Replacement Analysis (October 2021). Table 2 outlines roughly the number of years each vehicle type is kept for use before replacement.

Table 2. City of Irvine Replacement Schedule

Vehicle Type	Replacement Schedule
Sedans or Intermediate Vehicles	8-10 years
Public Safety Patrol Fleet	3-4 years
Pickup Truck and Cargo Vans	8-12 years
Animal Services Field Trucks	4-5 years
Heavy-duty Construction Equipment	15-25 years
Landscape Turf Equipment	8-12 years
Police Motorcycles	3-4 years
Canine Police Patrol Vehicles	3-4 years
Passenger Vans	6-10 years
Bus	3-5 years

Fleet Parking Locations

There are 246 vehicles/wheeled equipment located at the Operations Support Facility (OSF) at 6427 Oak Canyon, 255 located at Civic Center at 1 Civic Center Plaza, and 27 located across the Cypress, Heritage, Portola, Turtle Rock, University and Woodbury Community Parks. Table 3 illustrates the percentage of department vehicles at each parking location. Table 4 and Figure 1 show the parking locations for each type of vehicle in the fleet, with equipment shown in grey rows. There is a small portion of the fleet, undercover police vehicles, that park at employee homes overnight and are not clearly accounted for in Table 4. Note that the Civic Center parking is divided into two sections, secured and unsecured, because the parking location has a separate secured lot for Public Safety vehicles. General government vehicles and employee vehicles are parked in a different, unsecured area of the Civic Center lot.

Table 3. Percent of Total Department Vehicles and Equipment at Fleet Parking Locations

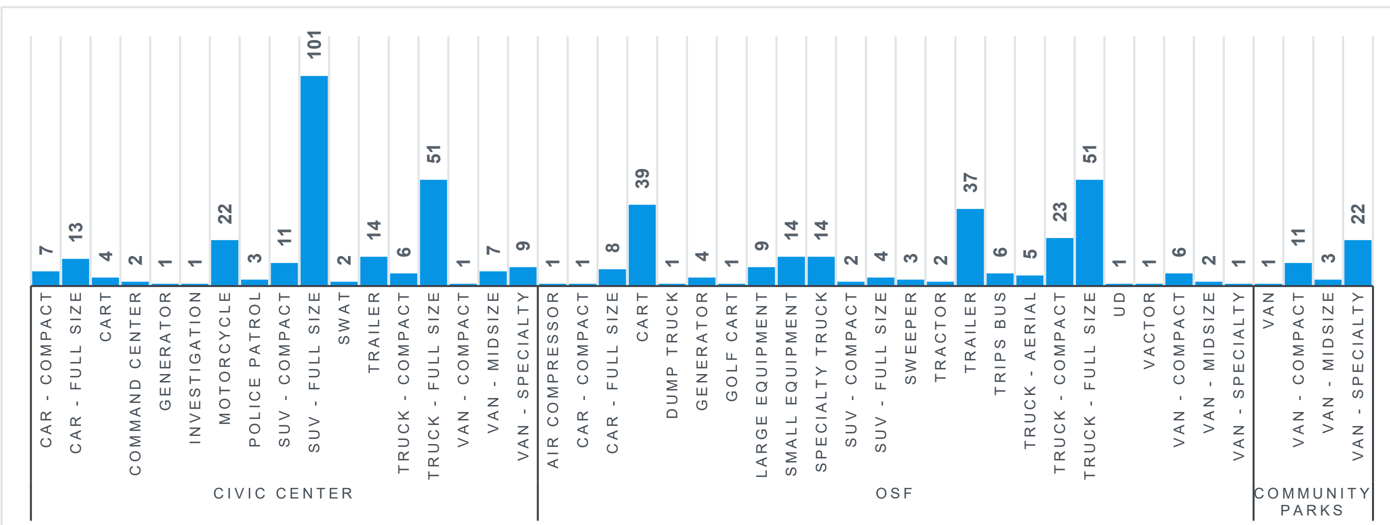
Parking Location	City Manager/City Council	Community Development	Community Services	Public Safety	Public Works
Operations Support Facility			15%		31%
Civic Center – Secured			<1%	40%	
Civic Center – Unsecured	< 1%	8%			
Various Community Park Locations			5%		

Table 4. Count of Vehicle and Equipment Type at Fleet Parking Locations

Vehicle	Operations Support Facility	Civic Center – Secured	Civic Center – Unsecured	Community Parks					
				Cypress	Heritage	Portola	Turtle Rock	University	Woodbury
Air Compressor	1								
Large and Small Equipment	23								
Generator	4		1						
Trailer		14							
UD (Diesel Equipment)	1								
Car – Compact	1		5						
Car – Full Size	8	11	2						
Cart & Golf Cart	40	4							
Mobile Command Center		2							
Dump Truck	1								
Investigation		1							
Motorcycle		22							
Police Patrol		3							
Specialty Truck	14								
SUV – Compact	2	9	2						
SUV – Full Size	4	100	1						
SWAT		2							
Sweeper	3								
TRIPS Bus	6								
Tractor									
Truck – Aerial	5								
Truck – Compact	23	5	1						

Vehicle	Operations Support Facility	Civic Center – Secured	Civic Center – Unsecured	Community Parks					
				Cypress	Heritage	Portola	Turtle Rock	University	Woodbury
Truck – Full Size	51	22	29						
Vactor	1								
Van – Compact	7		1	1	3	2	1	2	1
Van – Midsize	3	7			1				1
Van – Specialty	8	9		1	9		2	2	1
Total	**246**	**213**	**41**	**2**	**13**	**2**	**3**	**4**	**3**

Figure 1. Count of Department Vehicle and Equipment Type at Fleet Parking Locations



It is important to note that the OSF is included in a joint renovation project with the Irvine Animal Care Center. The project is currently in the early stages of design. The proposed scope of the OSF portion of the project includes demolition of four existing buildings, renovation of paving to accommodate 179 fleet parking spaces and almost 200 staff and visitor parking spaces, construction of new solar canopies and two diesel tanks, one gasoline tank, a natural gas fueling station (CNG island), and 10 electric chargers.

Energy Infrastructure

Gasoline, Diesel, and Renewable Natural Gas

The city has existing gasoline and diesel infrastructure. Both diesel and gasoline are readily available fuel sources as pipes are already in the ground at both the Civic Center and OSF facilities (Figure 2). There is a

20,000-gallon tank for regular gasoline and 10,000-gallon tank for diesel at the Civic Center. At OSF, there is a 20,000-gallon tank for regular gasoline and two diesel tanks, one 10,000-gallon Underground Storage Tank (UST) and one 750-gallon Above Ground Storage Tank (AST). However, for natural gas, the city only has infrastructure at OSF (Figure 3). The city is currently under a five-year contract with provider Clean Energy, from April 2017 to March 2022, for operation and maintenance of a publicly accessible natural gas fueling station at the OSF. The city reported that 100% of the natural gas purchased from Clean Energy is renewable natural gas (RNG). The city is plans to renew their contract into 2027 (an additional five years). The RNG station is available for public use and is frequently utilized.

Figure 2. Existing Gasoline and Diesel at Civic Center

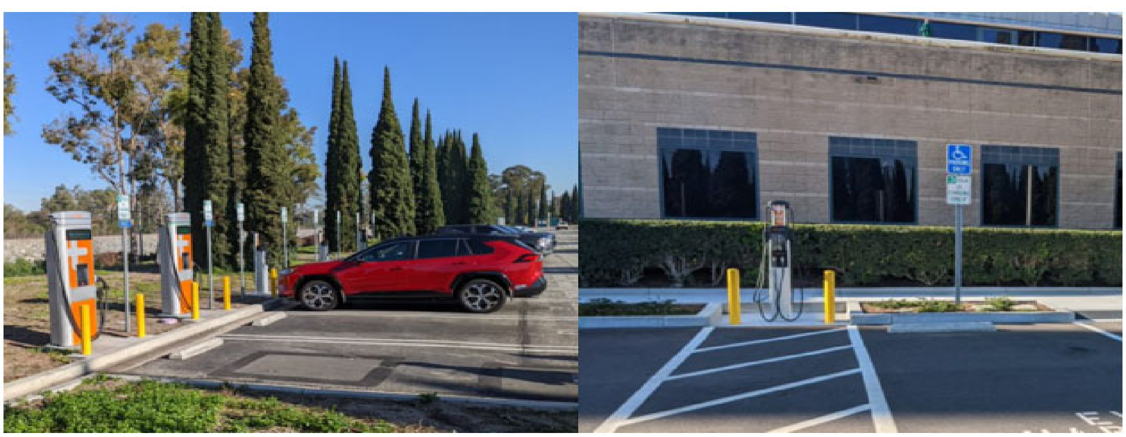
Figure 3. Existing Gasoline, Diesel, and Renewable Natural Gas Stations at OSF

Electric

Electrical service is currently provided to the city by Southern California Edison (SCE), one of the country's largest electric utility providers. For electric vehicles, there are currently 16 existing charging stations, including two at the OSF, 10 at Civic Center and 5 public chargers at the Irvine Train Station. There are two existing Clipper Creek Level 2 single-connector electric vehicle charging station (30 amp, 240 volt) located at the OSF location for city fleet vehicles, with a second ordered and awaiting installation in the neighboring parking space (Figure 4). At the Civic Center, there are 10 chargers; there are four public ChargePoint (CP) dual-connector Level 2 stations (30 amp) with a total of eight SAE J-1772 plugs capable of charging eight vehicles at the same time (Figure 5). There are also two public CP 62-kW DCFC (174 amp) stations. Each DCFC has two connectors: a CHAdeMO and a CCS-1. Each DCFC can only charge one vehicle at a time. SCE Meter No. 259000-090661 serves the two panels (277/480V) that distribute power to the DC fast chargers and the AC chargers in the parking lot(s) at the Civic Center. Within and around the secured lot, there is already a lot of power, including 110 outlets on light poles and the publicly available charging stations. At the Irvine Train Station, there are 2 single-port (ADA) units in the parking structure as well as 3 dual-port units in the surface lot. All 8 EV parking stalls are public, and there are no fleet vehicles that regularly charge at this location.

Figure 4. Existing Electric Vehicle Charging Stations at Operations Support Facility

Figure 5. Existing DCFC and L2 Electric Vehicle Charging Stations at Civic Center



V. Electrification Analysis

Key Findings

The following items are the main findings from the city fleet analysis; each is discussed in further detail later in this section.

Fleet Analysis

- **152 Public Safety vehicles subject to CVC 165 were exempt from the fleet analysis.**
    - There are limited ZEV options for pursuit-rated or special service vehicles with the durability required for typical law enforcement patrol vehicles.
- **Of the 295 vehicles included in the analysis, 137 vehicles (almost 50%) are candidates for replacement with a PHEV or BEV by FY 2028.**
    - Feasibility for replacement was determined based on the expected useful life of the vehicle and the expected availability of an electric replacement for the vehicle type.
- **Six light-duty vehicles scheduled for replacement during FY 2022–23 have feasible plug-in hybrid electric vehicle (PHEV) alternatives.**
    - Note, that although PHEVs are a recommended alternative to conventional vehicles, if the city can install the required EVI to support full BEV replacements, BEV replacements are recommended. In FY 2022-23, there are more vehicles, at least 10, scheduled for replacement with feasible BEV alternatives.

Infrastructure and Siting Analysis

- **Investment in electric vehicle charging infrastructure should be the first step the city takes in transitioning to an electric fleet.**
    - The city cannot procure EVs and expect them to be effective for department needs if there are no means to properly charge and maintain the vehicles.
- **The one-to-one replacement schedule developed during the fleet analysis informs the number and type of charger needed per parking location, totaling 32 dedicated 120v electrical outlets, 132 Level 2 chargers, and 18 DCFC chargers.**
    - Most of the chargers recommended are Level 2 at a 1:1 ratio with electric vehicles for redundancy. DCFC chargers are recommended for fast charging in the case of a double shift or emergency and for the heavier duty vehicles.
- **Distribution upgrades and new service will be necessary at both Civic Center and OSF to support the added electrical load from EV charging.**
    - There is about 6 MW of additional load capacity available at Civic Center and 18.5 MW of additional load capacity available at OSF.

Methodology

Fleet Inventory Analysis Methodology

First, trailers, tanks, and other equipment were excluded from the fleet listing. Next emergency vehicles, as defined by California Vehicle Code 165 (CVC 165), were excluded from the listing because these vehicles are currently exempt from California emissions regulations. The city's Public Safety department has about 152 vehicles that were exempt from the fleet analysis per CVC 165, but CSE's analysis includes the Public Safety support vehicles — non-CVC 165 — used by civilians. Further explanation about the Public Safety fleet analysis is provided in the next section.

After eliminating the emergency vehicles from the fleet inventory, CSE began by reviewing the existing conditions and evaluating the remainder of the existing fleet by age, annual mileage, and/or fuel usage. In the first step of the analysis completed, total existing vehicle usage was evaluated to identify low-use vehicles that could be removed from the fleet altogether. Identifying where a fleet can be trimmed not only reduces the overall number of vehicles in the fleet, but it also reduces the amount of EVI that the city will need to purchase and/or install. While considering removing low-use vehicles from the fleet, it is also important to keep in mind the city's potential future growth, which may impact the city's future usage needs. For example, over the past two decades, the city has experienced significant growth, and development is expected to continue, as will the demand for city services. For the city's fleet, CSE only identified a limited number of potential low-usage vehicles that could potentially be eliminated, and some of these vehicles may already be awaiting disposal. Because of the city's anticipated growth in the coming decade and growth in demand for additional city services, these vehicles were ultimately not removed.

CSE then identified 137 remaining vehicles that would be subject to the pending CARB ACF regulations, due for replacement and could be replaced with existing EVs by FY 2028. An additional 45 vehicles were also identified that could be replaced through 2030 and beyond — mainly compact and full-size cars and SUVS, light trucks, and vans. Potential replacement vehicles' daily duty cycle, battery sizes, and onboard chargers were evaluated to determine a suitable replacement. For one example, the city has an F-150 pickup truck that will be 12 years old in 2023. The city's proposed fleet replacement criteria indicates that pickups and vans should be replaced every eight to 12 years. The typical usage for the city's F-150s is between 6,000 and 12,000 miles per year, or about 125 to 250 miles per week. A suitable EV would have at least 150 miles per charge, if charged twice a week and only used on weekdays. Vehicles that were not recommended for a ZEV replacement were left out because no suitable ZEV equivalent currently exists. In the near term, there is flexibility in ZEV purchasing because only 50% of new or replacement purchases must be ZEVs. Per ACF, after 2027 the only vehicles that can be purchased for fleets are those that do not have ZEV equivalents.

Infrastructure Analysis Methodology

After completing the fleet analysis and identifying a replacement schedule to guide the city in transitioning its fleet to meet CARB regulations, CSE analyzed the EVI required to support ZEV adoption in the near term and midterm. Using the replacement vehicles suggested in the 1:1 vehicle replacement plan and then the recommended vehicles for replacement beyond FY 2028, the quantity and type of EVSE needed at each of the city's sites were calculated based upon the class of vehicle, a suitable EV replacement's battery size, and the vehicle's parking location.

For instance, the Ford F-150 Lightning is a ZEV with an AER of more than 230 miles, has a battery pack that is approximately 112 kWh with 98 kWh usable, and a standard onboard charger that is 9.6 kW. The EVSE charging rate is determined by its circuit rating and the vehicle's onboard charger — whichever is lower. Today's standard Level 2 EVSE — like the existing Clipper Creek at the OSF or the existing ChargePoint units at the Civic Center — have a rated power capacity of 6.6 to 7.2 kW. If the truck were to use one of these EVSE, it would take almost 14 hours to fully recharge. Because of this, CSE recommends higher power Level 2 EVSE appropriate for charging each of the coming ZEVs. For the Ford F-150 Lightning in this example, CSE recommends at least a 48-amp Level 2 EVSE capable of 9.6 kW be installed to support this vehicle and similar trucks. The higher powered 9.6-kW EVSE can also support/charge vehicles with lower powered onboard charger (3.3 kW up to 7.7 kW) as well as those with higher powered onboard chargers (up to 19.4 kW).

The EVI development recommendations are presented in near-term and midterm format as the installation on EVI needs to be before the purchase of EVs. EVI considerations focused on the amount of energy needed if vehicles are left overnight and expected to be fully charged for use the following morning. Most of the city's vehicles will only need a charge every two to four days. However, a limited number of medium-duty vehicles, such as the TRIPs shuttles, will need to be charged nightly. One charger or port is recommended for every electric vehicle added to the city's fleet even with some vehicles not needing charging every day as to allow for future vehicles and to allow for backup charging options if some chargers need service. It will be advantageous for the city to install additional chargers in advance of EVs purchased beyond FY 2028. Level 2 chargers are recommended to be at least 11.5 kW (50 amps) to be able to charge the batteries of new EVs that are added to the fleet overnight (in eight hours or less). It also will be critical that the EVI network system manage the vehicle charging to avoid high-cost periods and/or tripping demand charges at these sites.

DCFC are recommended for when a fast charge is needed for a double shift or for an emergency response event. DCFC may also be needed for the city's larger vehicles with very large battery packs (300+ kW). These DCFC can recharge the soon-standard range pickup trucks or vans to 80% in less than 45 minutes. These DCFC will also recharge the city's larger medium-duty trucks, 15 passenger vans, and TRIPs shuttles, as well as support lighter duty vehicles during ongoing events. The city's real expense will be the larger transformer(s) and the additional electrical panels. Also, DCFC are recommended to be 120 kW for charging in about an hour or less. Based on recommendations from the U.S. Department of Energy Alternative Fuels Data Center, one DCFC charger should be installed for every nine Level 2 chargers to allow for a quick charge when needed. DCFC charging is recommended at Civic Center, OSF and Heritage Park.

The city should consider using two different charger manufacturers in case there is a service issue that impacts one one manufacturer's devices. If there were a problem, the second manufcturer's devices could still provide a backup.

A parking site analysis was also conducted to develop a charging plan for the city's fleet vehicles including locations, type of charging, and power levels for light-, medium-, and heavy-duty vehicles. CSE investigated the two primary fleet parking locations, Civic Center and the OSF, for potential infrastructure installation, as well as a handful of Community Parks. Each site will need infrastructure to support ZEVs. Additionally, the infrastructure analysis evaluates networking requirements (including reporting for grants and LCFS credits), hardware and software to control and manage charging, and fleet management strategies to minimize costs.

Fleet Electrification Analysis

Using the methodology described above to review the city's existing fleet, CSE developed recommendations for a new vehicle replacement schedule that the city could use as a guide to begin to electrify its fleet over time. Appendix B provides a proposed 1:1 vehicle replacement schedule for 137 city vehicles sorted by near-, mid- and long-term recommendations for replacing traditional fossil vehicles that are aging out of the fleet with new PHEV and BEV vehicles.

While ZEVs are the ultimate goal, in the early years, PHEVs may be a better near-term choice for the city because of the limited existing EV infrastructure. As the city installs EVI, the city's PHEVs will be able to operate primarily as ZEVs. Current PHEVs have a limited all-electric-range (20 to 40 miles). When the battery's charge is depleted, they operate as a conventional hybrid. Please refer to the following example based on the EPA's FuelEconomy calculator for a Ford Escape Please see both the Fuel Economy and the Energy and Environment tabs.

- Ford offers its Escape as a PHEV, a hybrid, and as a conventional SUV.
- The Ford Escape PHEV gets 40 MPG on gasoline. If driven 8,000 miles per year on gasoline, it will use 200 gallons of gasoline/year. However, when the city has more EVI and if charged nightly, this vehicle would operate the first 37 miles each day as a ZEV, likely for Years 2 to 10 of its useful life. Because the city vehicles, on average, have a relatively low mileage per day, this means the Ford Escape PHEV would primarily act like a ZEV for most of its useful life.
- The Escape Hybrid gets 42 MPG. If driven 8,000 miles per year, it will use 195 gallons of gasoline/year.
- The standard Ford Escape gets 30 MPG. If driven 8,000 miles per year, it will use 267 gallons of gasoline/year.

This example demonstrates that although a PHEV is still an exhaust-emitting vehicle, the environmental impact of a PHEV or a hybrid are significantly lower than a conventional vehicle due to the higher MPGs. When there is insufficient infrastructure or there is not an appropriate ZEV option, the city should consider a PHEV. If no PHEV option is available, the city should consider a hybrid. Only when a ZEV, PHEV, or hybrid version is not available should the city consider a conventional vehicle.

CSE made replacement recommendations each fiscal year by identifying which vehicles will be reaching the end of their useful life in that fiscal year, and then identifying which of these vehicles had feasible PHEV or ZEV replacement options. The recommendations provided each fiscal year indicate all vehicles that can be replaced by PHEVs or ZEVs, understanding that the city may not replace all vehicles with feasible PHEV or ZEV replacements in a given year. The city should consider a near-term 25% purchase requirement as a floor with an eye to increasing the number of the ZEVs as the fleet ramps up to 50% in 2024. As noted earlier, in 2024, 50% of the city's new commercial vehicles purchases will need to be either PHEVs, full BEVs, or FC vehicles. Simultaneously, increasing the percentage of ZEVs in fleet will assist the city in qualifying for SCE's Charge Ready program. As part of its program qualifications, the Charge Ready program requires that the city identify the number of ZEVs in the fleet, the number on order, and the number of employees who currently drive ZEVs. The city's purchases will be critical to qualifying for and leveraging SCE's EVI funding as well as funding from other sources. (Refer to the Funding Opportunities section below for more information.)

There were a limited number of specific high use/or high fuel use vehicles within the city's fleet. Specifically, three trucks used for the athletics program (approximately 16,000 to 25,000 miles each per year) and some of the city's 15 passenger vans and TRIPs shuttles. All these vehicles should be within the range of today's EVs but will require dedicated and nightly charging. Because the city currently has limited charging infrastructure and there are a limited number of fully electric SUVs available on the market, PHEVs are proposed as a bridge for fleet transition in the near term or if there are not currently suitable replacements in the midterm. As the city installs its new EVI and more BEV options come to market, the city should shift focus to full BEVs.

The city's fleet management team will have the flexibility to select a vehicle that best fits the city's needs at the time of replacement. For example, for a Ford Escape, the 1:1 replacement schedule proposes either a Ford Escape PHEV or a Chevy Bolt EUV. Either option helps the city meet its goal to begin electrifying its fleet. It also allows the department to select the vehicle that best fits the city's needs and access to charging infrastructure. Additionally, some existing fleet vehicles can be identical in make and model (a Ford F-150 with a Ford F-150 Lightning), but other replacement vehicles proposed are different. This was done intentionally to allow flexibility across manufacturers and models as well as to reflect what is currently available or will be available within the next 12 months.

Public Safety Fleet

The Public Safety fleet consists of patrol vehicles, non-patrol vehicles, and support vehicles. Most of the CVC 165 vehicles used by Public Safety are pursuit-rated or special service vehicles and are therefore excluded from our replacement analysis as there are limited ZEV options in this niche market.

Typical law enforcement patrol vehicles are designed for multiple shifts per day. They also are designed to be more durable and to withstand constant and heavy use. Their bodies, suspensions, and braking systems have been designed, engineered, and tested for this duty cycle. ZEV equivalents of these vehicles will need to be recharged quickly between shifts. Most of today's vehicles can be recharged in less than an hour — but that may not be sufficient for patrol vehicles. Several developments will enable the much faster charging: 800+ volt systems, solid state batteries, and ~350-kW DCFC. Today, the Porsche Taycan, as well as the new Hyundai Ioniq 5 and KIA EV6 have 800+ volt systems. These vehicles can be recharged to 80% in as little as 10 minutes. Regularly recharging the current generation of batteries this quickly can accelerate battery degradation. Next generation solid state batteries will have both higher capacity and will be more tolerant of high-speed fast charging — necessary for patrol service.

Ford, the current market leader in the police vehicle market with products like the Explorer Interceptor and the F-150 Responder, years ago offered the Plug-in Fusion Responder but has since discontinued the vehicle. The Ford Mach-e has passed the Michigan State Police's performance testing, and the New York City Police Department has ordered approximately 170 Mach e's for Patrol Service. However, it may be sometime before Ford has sufficient production capacity to begin actively marketing the Mach-e to departments throughout the country. Additionally, while the Mach-e passed the Michigan State Police performance testing, its interior and truck space may not be a sufficient replacement for existing Public Safety patrol services vehicles. Several jurisdictions have various Tesla models in patrol service as marked police vehicles. However, these vehicles are not yet pursuit rated. The city could have liability exposure if a non-pursuit rated or non-special service vehicle were to be used in patrol. Therefore, due to the existing barriers of replacing CVC 165 vehicles with ZEVs, these vehicles were excluded from the electrification study.

The city and its Public Safety Department should anticipate that when the manufacturers produce pursuit-rated ZEVs, the transformation of the Public Safety's patrol vehicles and motorcycles will occur very quickly the vehicles' more frequent replacement due to higher usage. Other reasons include the superior performance of the ZEVs, their reduced maintenance, and their lower total cost of ownership (TCO). The department's 60 patrol vehicles and 22 motorcycles are on a much shorter (3 to 4 year) replacement cycle. Once these vehicles are available, the city should anticipate that most all its gasoline-powered patrol vehicles will be replaced within period of five to six years.

EVI Analysis

In the City of Irvine, almost all the city vehicles, excluding a limited number of home-assigned vehicles parked at employee residences overnight, are located at one of two sites, the Civic Center or OSF. Additionally, 27 vehicles, all Ford Transit vans or Ford E350 15 Passenger vans, park across six different Community Park locations. Table 5 estimates the quantity and the charge rate for dedicated 120v outlets for electric carts, the Level 2 EVSE at each site, and the appropriate number and minimum charge rate for the DCFCs at each site based on the 182 proposed BEV/PHEV replacements to support beyond FY 2030. Home assigned vehicles would need a 220-volt outlet that is accessible to the parked vehicle (within 20 feet) and a Level 2 portable charger to support EVs. There are 32 dedicated 120v outlets, 132 Level 2, and 18 DCFC connectors recommended.

Table 5. Number and Type of EVSE Recommended to Install by Location

Parking Location	Time Frame	Dedicated 120v Outlets (Carts Only)	# of L2 Ports	Type of L2 Ports	# of DCFC Ports	Type of DCFC Ports
Operations Support Facility	Near Term	30	14	40-50 amp, up to 9.6 kW	8	Min. 120 kW capable of charging two vehicles at the same time; 150 kW to be eligible for some incentives
	Midterm	-	37	60-100 amp, 11.5-19.2 kW	5	
Civic Center – Secured	Near Term	2	6	40-50 amp, up to 9.6 kW	1	
	Midterm	-	12	80-100 amp, 19.2 kWh	1	
Civic Center – Unsecured	Near Term	-	4	40-50 amp, up to 9.6 kW	2	
	Midterm	-	42	60-100 amp, 11.5-19.2 kW	-	
Cypress Community Park	Near Term	-	2	-60-100 amp, 11.5-19.2 kW	-	
Woodbury Community Park	Near Term	-	2	-60-100 amp, 11.5-19.2 kW	_	
Heritage Community Park	Near Term	-	7	60-100 amp, 11.5-19.2 kW	1	
Turtle Rock Community Park	Near Term	-	2	60-100 amp, 11.5-19.2 kW	-	
Portola Community Park	Near Term	-	2	60-100 amp, 11.5-19.2 kW	-	
University Community Park	Near Term	-	2	60-100 amp, 11.5-19.2 kW	-	

The current generation BEVs (those with a range of 200 to 260 miles) will only need to be charged every two or three days due to the high useable AER of about 120 to 150 miles per charge and the city's typical average daily mileage requirements. However, the city should consider installing one EVSE for each vehicle for at least two reasons. The first is redundance. Due to hardware failures and/or software issues, etc., the city should not expect every EVSE to work flawlessly 24/7/365. Without redundancy, the city vehicles relying on malfunctioning equipment will not be able to charge and the productivity of the city employee or employees may be impacted. The second reason the city should install one EVSE for each vehicle is that it ensures that the city will have sufficient infrastructure for future growth. For example, current development in and around the city's Great Park will significantly increase the city's population and demand for services. Additionally, CSE recommends the city select EVI from at least two different manufacturers at each site. This variety would ensure that if there is a problem or issue impacting one manufacturer's EVSE or DCFC, it will not completely shut down charging at the site.

At any other site where EVs may be parked, the city should abide by this rationale and install one EVSE per parked vehicle. Additionally, city should consider maximizing the value of the city's infrastructure by making public chargers available at community locations. This would include separate chargers for city vehicles vs. public use. Unlike the city's chargers for its fleet vehicles, public chargers would have to comply with ADA and State regulations. For example, public chargers are required to have credit card readers and be tested and certified by the County's Weights and Measures.

EVI Siting Recommendations

In 2015, the California Public Utilities Commission issued Rulemaking 14-08-013 requiring public utilities to publish a Distribution Resource Plan (DRP), which included an Integration Capacity Analysis (ICA) for each electrical line in the distribution system. The ICA quantifies the maximum amount of power that can be injected to, or drawn from, the distribution system requiring minimum to no distribution upgrades or operational restrictions. This data is published to an interactive web portal that is periodically updated and provides access to, among other things, the amount of generation and load that can be added to the distribution line.

Load and generation, especially solar, fluctuates throughout the day, and the most limiting conditions on the most limited day and hour were used to determine integration capacity. The amount of load that can be added was limited by the amount of load installable at that location without violating any thermal or voltage requirements on the line. Integration capacity values do not guarantee that no distribution upgrades will be required and should be treated as guidelines.

The ICA was used to analyze the Civic Center and the OSF, the two primary fleet parking locations, to determine if existing distribution lines could support the addition of a large EV charging load. The impact of an increased volume of EVs in the city fleet is explored in greater detail in the Distributed Energy Resources (DER) Implementation Plan, including at the community park locations where a small portion of the city fleet are parked.

Civic Center

The Civic Center grounds have three distribution lines running to it, as shown in Figure 6. Presumably, one each for City Hall, the Police Headquarters, and the fueling depot (circuits 1-3 shown below). Unfortunately, none of these have room for the addition of EV load. Nearby circuit 4 has room for as much as 6 MW of added load, but it is almost certain that distribution upgrades will be required for Civic Center EV charging. There is plenty of space to add solar PV to any of the circuits (Table 6).

Figure 6. Civic Center Siting Recommendations

Table 6. Civic Center Integration Capacity Analysis

Integration Capacity Analysis		
Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	3.72	0
2	4.16	0
3	4.68	0
4	21.08	6.27

The unsecured area next to the gasoline stations that is currently used for Community Service vehicles would be the easiest area to install additional charging stations. There are also a few areas within the secured lot available for light pole charging and for a line to be run against the back wall.

Operations Support Facility

The OSF is fed from four distribution lines, feeding various buildings around the site. All four lines have room to add several MW of EV load and solar PV, as shown in Figure 7 and Table 7.

Figure 7. Operations Support Facility Siting Recommendations

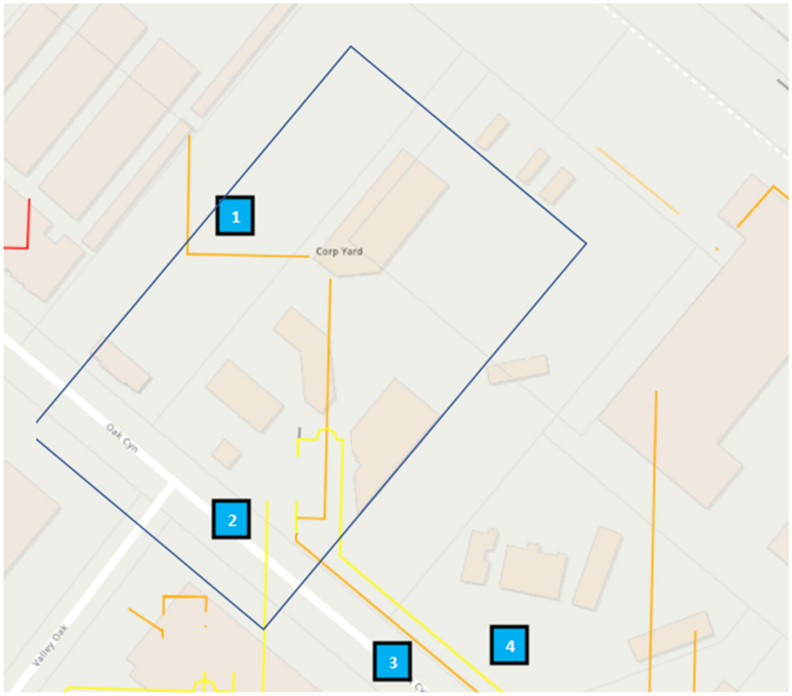


Table 7. Operations Support Facility Integration Capacity Analysis

Integration Capacity Analysis		
Distribution Segment	Solar PV Capacity (MW)	Added Load Capacity (MW)
1	4.36	3.01
2	9.34	5.94
3	4.74	3.53
4	14.96	6.23

OSF currently has one charger already functioning outside of Building 3. The city should focus additional chargers around Building 3 to ensure ease of electrical installation. Additionally, the city has plans to to rehabilitate the OSF, including adaptations to multiple buildings, parking lots, and the neighboring dog park. Due to the urgent need for EVSE installation, the city should install EVI in areas that will not be affected by the redevelopment, such as in the row of parking in front of Building 3. Then, the city can add additional chargers in areas of simpler electrical installation after the redevelopment of the site.

Fleet Management and Telematics

Technology providers monitor each fleet vehicle's location, state of charge, and proximity to charging infrastructure. Some technology provider's systems can monitor electric vehicle charge completion time, charging station availability, and charger queues as well as depot power consumption. Functionality varies widely by provider. Some are focused on light-duty vehicles, while some can manage light-duty and commercial vehicles. Some will also fully integrate with various fleet management systems so that fleet staff have a single dashboard and do not have to toggle between the fleet system and the telematics system.

- **Automated Load Management:** Electrical demand peaks in the afternoon as vehicles return to their facilities at the end of the workday. Demand drops off considerably after 9 p.m. and over weekends when fewer employees are working. Delaying charging and automated load management software will be critical to managing the increased load from fleet electrification. Delayed and automated charging management will significantly lower the city's energy costs compared to uncontrolled charging, especially during peak periods (4-9 p.m., Monday through Friday). Uncontrolled or unmanaged charging during peak hours adds additional and unnecessary load to the grid and may trigger or increase demand charges. Managing ***when*** vehicles charge should be a key city strategy for managing its electrical load. One effective strategy is programming EVSE with delays. When vehicles return to base, the driver plugs in the vehicle and authorizes the charge, but the vehicles do not begin to charge until 9 p.m. or later when the grid has ample power, the rates are lower, and there is virtually no risk of triggering demand charges.

- **Telematics**: System records and reports on vehicle data such as SOC (state of charge), vehicle location, odometer, and battery health. Rules and notifications can be selected to notify the fleet manager when a vehicle drops below a set SOC. State of charge can also be used to prioritize the charging order, moving vehicles with a low SOC to the front of the queue. Multiple fleet types can be configured such as sedans, SUVs, pickups, TRIPs shuttles, etc. Plug-in hybrid metrics can also be monitored to minimize fuel usage.

- **Charge Scheduling**: Charge scheduling or managed charging should be a key city fleet electrification strategy. If both the telematics and the charging software include this functionality, the city will need to determine whether the network charging software or the telematics solution will provide this functionality. Fleet management can automatically or manually configure a charging schedule to ensure the lowest possible charging cost and full state of charge for each vehicle. Fleet manager approval can be required to approve charging during peak rate periods. Telematics also can provide real-time updates of arrival times and expected completion (route) times, as well as adapt to unforeseen circumstances.

- **Energy Management**: Some telematics permit the loading of utility rate schedules into the software to avoid charging during peak periods and offer more advanced grid services such as demand response. In the coming years, vehicle to grid will also become available.

Some of the solution providers:

- Amply

- Driivz
- Electriphi
- Ford Telematics
- Geotab
- MOEV
- PowerFlex
- Samsara
- Verizon

Some networks like ChargePoint and Flo have used proprietary EVSE. The ChargePoint or Flo EVSE will only work with their respective networks. Other EVSE and many DCFC and networks use open protocol OCPP. New pubic EVI requires that networks use OCPP EVSE and DCFC. If the city uses proprietary EVSE or DCFCs, the city will have to replace the EVSE or DCFC if it opts to charge network providers. OCPP-compliant EVSE and DCFC makes it easy for the city to switch from one network provider to another without replacing the charging hardware.

The data from the city's fleet charging, and its evolving charging patterns, will be important to the city as it develops its EVI roadmap. This data is also valuable to the network providers and to the vehicle manufacturers. Network providers sometimes sell the data that they gather. The city's charging agreements should reflect the level of granularity that the city is willing to let the network have and/or sell. If a network uses proprietary EVSE and it goes bankrupt or is sold to another firm, the city may have to replace its EVSE and/or walk away from its historical data. The city should require open protocol equipment and networks and insist on retaining its historical data.

In the coming decade, the city should anticipate having EVSE/DCFC from multiple firms controlled by multiple network providers. To the extent possible, it would be best to have all the city's data on a single dashboard. In its Phase One funding, Electrify America required open protocol EVSE/DCFC and open protocol network providers. Pacific Gas and Electric and Electrify America each developed their own APIs so that they could view the disparate networks and EVSE/DCFC on a single dashboard. Both EA and PG&E required that the networks provide data streams to their APIs, regardless of whether the networks were OCPP compliant or a proprietary network. The city should consider creating its own API and dashboard where it can maintain its historical data.

VI. EVI Community Analysis

In addition to reviewing the city-owned fleet, CSE was also responsible for assessing EVI infrastructure development needs for the broader Irvine community to help support increasing adoption of PHEVs and BEVs. The EV/EVI community assessment focused on projecting EV registrations in Irvine through 2030 and understanding areas of interest in the city that are in most need of EVI in the coming years. EV registrations were projected for both business-as-usual (BAU) and BBB EV incentive scenarios. CSE used projected EV registrations, vehicle miles traveled, and current EVI to determine which critical care centers, Title 1 schools, and high-density residential parcels within the ZIP code 92618 should be targeted for future EVI.

Key findings:

- Around 50K new EV registrations through 2030 in business-as-usual scenario
- Around 75K new EV registrations expected through 2030 in BBB scenario
- Highest priority EVI locations among critical care facilities are Portola High School, Northwood High School, and Portola Springs Community Center
- Highest priority EVI locations among Title 1 schools are Cadence Park K-8 and Northwood Elementary
- ZIP code 92618: A single group of medium to high density parcels in Portola Springs and several in Oakcreek were identified as of high EVI priority
- ZIP code 92618: Apartment complexes Solaira at Pavilion Park in Great Park, Portola Place Apartments in Portola Springs, and a few apartments in Oakcreek were identified as high EVI priority

Data Sources

Vehicle Registration Data

EV projections were based on registration data licensed from IHS Markit. The data include monthly new light-duty vehicle registrations in California. Registration data is further categorized by vehicle fuel type: gasoline, diesel, conventional hybrid, plug-in hybrid, battery electric, and fuel cell vehicles. Census tract information is available for each of the registrations from March 2010 through December 2020.

EVI Data

Currently available public charging station data for the City of Irvine was collected using the Alternative Fueling Station Locator tool developed by Alternative Fueling Data Center. The data is gathered by the National Renewable Energy Laboratory. Information on new charging stations is obtained from Clean Cities coordinators, trade media, the submit new station form, station locator website, and collaborating with OEMs, fuel providers, and other industry groups. The charging station data includes EV charging station count, number of EVSE ports, type of connectors, and available charging network at each charging station location.

Vehicle Miles Traveled Data

The vehicle miles traveled (VMT) data includes average daily traffic counts in Irvine. VMT data for 2019 and 2050 projections was provided by Ascent, who are contracted with the City of Irvine to provide a Climate Action and Adaptation Plan (CAAP).

Housing Data

The housing characteristics data such as housing occupancy, type of housing unit, etc., was collected using the 2019 American Community Survey (ACS). The data includes important housing characteristics by block groups. A block group is a combination of census blocks and a subdivision of census tracts. Each block group contains between 600 and 3,000 people.

City of Irvine and Other Geographic Boundaries

Geographic boundaries of City of Irvine were created using polygon shapefiles published by the California Department of Transportation as of 2015. The data was created by extracting city boundaries from the Tax Area Services Section of the California Board of Equalization 2013-15 data release. Other geographic boundaries for block groups and census tract were gathered using United States Census Bureau.

Methodology

To accelerate the growth of EV and EVI infrastructure, CSE first examined historic EV registration trends in City of Irvine. CSE used the new vehicle registration data in California and narrowed the scope to City of Irvine using the census tract information provided in the registration data. The data was extrapolated to 2030 using the Prophet forecasting procedure developed by Facebook. Prophet is an open-source forecasting tool that forecasts time series data based on an additive model where nonlinear trends are fit with yearly, weekly, daily seasonal effects of the data. The tool also handles outliers and missing data. The Prophet tool was used to consider seasonal trends present in EV registration data. The EV forecast generated (Figure 8) is a BAU scenario as it is based on current incentives available to consumers. It does not consider any future policy interventions.

Next, CSE created a policy intervention scenario based on the BBB Act EV legislation. The act gives consumers buying EVs an additional $6,829 incentive on average, as calculated by CSE'S Caret policy simulation software. The BBB-EV scenario incentive amount was used as a multiplier of the original projections to estimate the growth of EV adoption due to BBB legislation through 2030.

Additionally, CSE examined EV projections at census tract level to recognize current distribution of EV registration in the city. The purpose of this segment of the analysis was to get more granularity on current market share of EVs in census tracts and predict future market share based on the historic EV sales in Irvine.

A geospatial analysis was conducted based on current 2019 VMT data and 2050 VMT data projections provided by Ascent. This analysis included current EVI charger locations in the City of Irvine to examine the relative urgency to add charging stations to meet consumer demand in 2050. The VMT projections estimate the future traffic volume in each Traffic Analysis Zone, and the number of cumulative charging stations within the zone are used to assess unmet consumer demand.

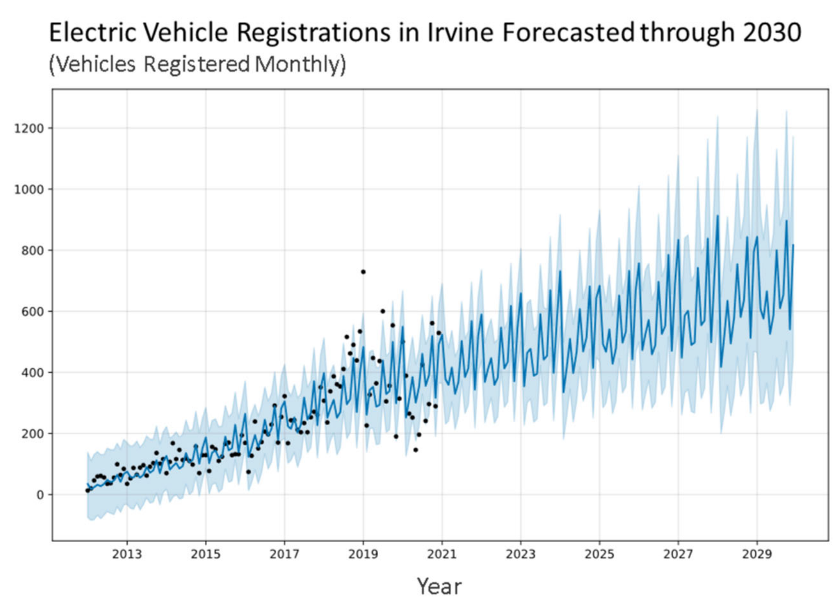
CSE developed a scoring metric “EVI score” for census tracts to identify census tracts that have a high and low number of EVs to charging station ratio. Based on the resulting score, these areas are ranked from high to low EVI Score as locations that are most in need of charging stations to areas that are closer to meeting demand. The EVI score is meant to help the city determine potential “hotspots” for future EV charging station installations. The city provided a list of places of interest (Appendix C), which included a list of priority MUD and disadvantaged community ZIP codes, schools, community centers, and senior centers. These priority locations, along with areas of high residential population, were included in the EVI analysis to better understand the variation of EVI score in the priority locations.

EV Growth Analysis

Business-as-Usual Projections

Per monthly EV registrations in Irvine from 2010-21, there is an upward trend in electric vehicle registrations. This forecast for years 2022 through 2029 shown in Figure 8 affects a BAU scenario inclusive of current incentives available to consumers. The dots in Figure 8 show monthly EV registrations until December 2021. The line graph shows the forecast algorithm generated monthly electric vehicle registrations through December 2029. The graph also shows wide error bounds around the projections reflecting unstable trend in future EV registrations.

Figure 8: Monthly EV Registrations in City of Irvine



The monthly projections are pooled into yearly totals in Table 8. Through 2020, around 27,000 electric vehicles were registered in Irvine. Over the next nine years, an additional 51,000 are projected to be registered in a BAU scenario. The yearly projections of EV registrations increase each year from 4,867 in 2021 to 7,744 in 2029. In total, almost 79,000 EVs will be registered in Irvine by the start of 2030. Note that the cumulative total does not account for vehicle retirement, so the number of electric vehicles on the road will be slightly smaller than the cumulative number registered.

Table 8: Forecasted New EV Registrations Between 2022 and 2029

Year	Projected New EVs Registered	Lower Bound	Upper Bound	Cumulative EVs
2021	4,867	3,591	6,654	27,030
2022	5,226	3,876	7,080	32,256
2023	5,586	3,970	7,755	37,842
2024	5,946	4,112	8,265	43,788
2025	6,306	4,365	8,820	50,094
2026	6,665	4,464	9,467	56,758
2027	7,024	4,354	10,373	63,783
2028	7,384	4,338	10,972	71,167
2029	7,744	4,377	11,784	78,911

Build Back Better Projections

EV registrations in the BAU scenario are used as a baseline to project EV registrations under the BBB Act electric vehicle legislation. We assume BBB-EV would not be enacted until the close of 2022, so we apply a weighted average incentive of $6,829 per vehicle starting in 2023. We multiply BAU projections by an additional 7.5% for every $1,000 of subsidy incentives, based on findings in Wee et al. (2018). In 2023, projected EV registrations increased from 5,586 to 8,447, and in 2029, projected EV registrations increased from 7,744 to 11,710. By 2030, around 24,000 additional EVs are expected to be registered due to BBB-EV incentives (Table 9).

Table 9: Forecasted New EV Registrations Based on the Build Back Better Electric Vehicle Legislation

Year	Projected EVs BAU	BBB-EV Projected EVs	BBB-EV Cumulative EVs
2021	4,867	4,867	27,030
2022	5,226	5,226	32,256
2023	5,586	8,447	40,703
2024	5,946	8,991	49,694
2025	6,306	9,536	59,230
2026	6,665	10,079	69,309
2027	7,024	10,622	79,930
2028	7,384	11,166	91,096
2029	7,744	11,710	102,807

The EV projections for both scenarios were created from vehicles registered by census tract. Each census tract has a portion of total EV registered in Irvine, which we call EV market share. We will use the EV market share values of each census tract in Irvine as reasoning to build future electric vehicle infrastructure at locations within them in subsequent sections.

Community EVI Siting Analysis

Projected Vehicle Miles Traveled and Current Public EVI

VMT projections indicate that traffic will grow heterogeneously in Irvine. Figure 9 and Table 10 illustrate how the VMT is expected to change among the traffic analysis zones (TAZs) from 2019 to 2050. Additionally, Figure 10 shows existing electric vehicle charger locations with a 1 kilometer buffer. Note that areas within high VMT areas have no EV charging locations close by. These locations will have higher EVI scores indicating high need for future EVI.

Figure 9: Heat Map of High Traffic VMT Locations by TAZ in Irvine in 2019 and 2050

2019 VMT Totals | 2050 VMT Projections

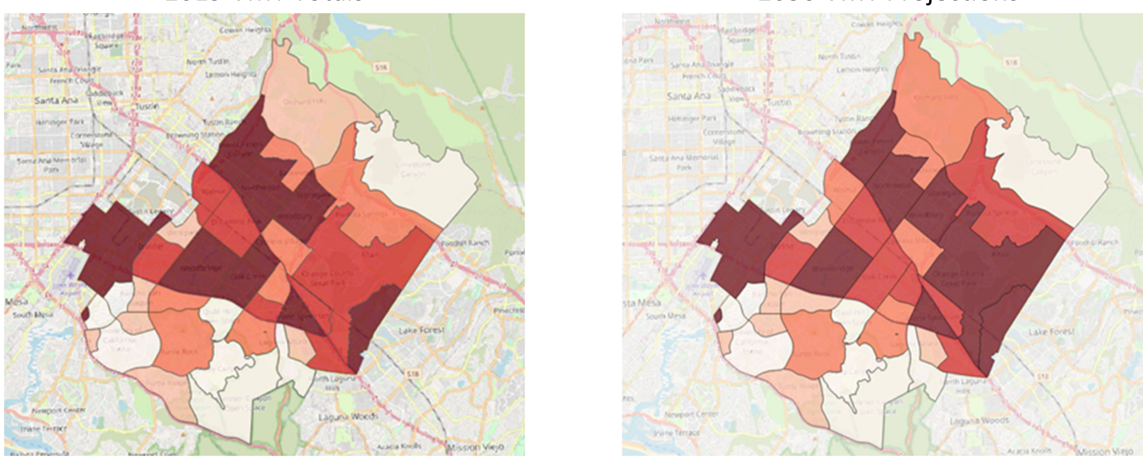


Figure 10: 2050 VMT Projections and Current Electric Vehicle Infrastructure

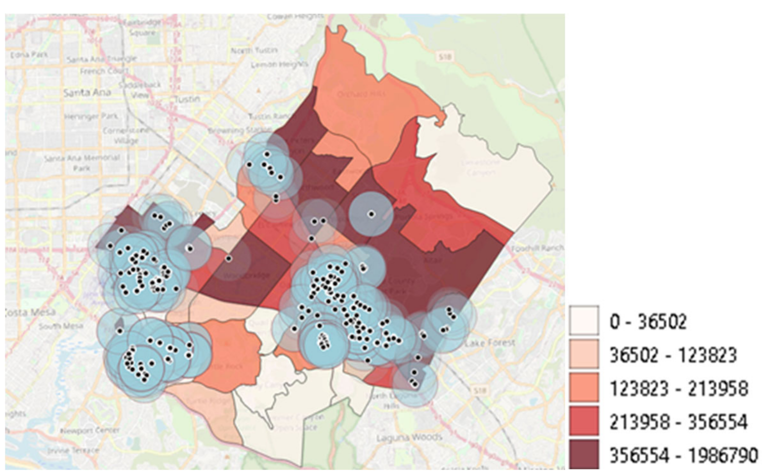


Table 10: Forecasted VMT by TAZ in 2050

TAZ	2050 VMT	Percent Change Since 2019	Current EV Charging Stations	Places of Interest
36	1,986,789.84	-3%	145	0
35	459,297.81	-6%	20	0
4	454,707.92	0%	16	0
33	437,023.13	6%	62	0
15	431,451.74	0%	1	7
8	393,025.50	0%	3	1
51	380,994.59	59%	16	2
9	359,486.01	3%	6	2
12	344,825.23	3%	27	1
32	294,688.49	-1%	22	0
11	276,692.32	-2%	3	6
34	250,656.26	0%	3	0
14	237,498.76	-1%	6	3
31	226,861.78	20%	65	0
6	213,970.98	20%	0	1
1	213,937.35	96%	0	1

EVI Scores for Places of Interest

Irvine stakeholders identified places of interest for future EVI stations. The places of interest are either critical care centers (Table 11) or Title 1 schools (Table 12). The "Priority for EVI Score" column is calculated by the number of existing EV chargers within 1 kilometer, the 2050 VMT projections of the associated TAZ, and the EV market share of the associated census tract. A higher score means that the location is in most need of EV chargers in the future. The scores are meant to give priority among the list of places provided. Among critical care centers, Northwood School, Portola High School, and Portola Springs Community Center are in most need. Among the Title 1 schools, Cadence Park School is of highest priority and then Northwood Elementary and Cadence Park K-8.

Table 11: Priority EVI Score for Critical Care Centers

Critical Care Centers and Parks				
Location Name	**Priority for EVI Score**	**EVI within 1 KM**	**TAZ VMT (2050)**	**Census Tract EV Market Share**
Northwood High School	10.0	0	213937.3495	8%
Portola High School	11.4	0	380994.5915	7%
Irvine High School	5.0	2	276692.3204	1%
Woodbridge High School	6.1	1	431451.7426	1%

Critical Care Centers and Parks				
Location Name	Priority for EVI Score	EVI within 1 KM	TAZ VMT (2050)	Census Tract EV Market Share
University High School	0.1	7	202763.9191	1%
Sweet Shade Neighborhood Park	1.2	6	109287.878	2%
Irvine Civic Center at Colonel Bill Barber Marine Corps Memorial Park	1.0	6	237498.7611	1%
Portola Springs Community Center	9.3	0	213970.9834	7%
Los Olivos Community Center	5.8	1	50522.54688	3%
Turtle Rock Community Center	6.8	0	202763.9191	1%
Las Lomas Community Center	7.8	0	96987.99792	7%
Quail Hill Community Center	4.4	4	124717.8341	7%
University Community Center	6.9	0	123226.8397	2%
Rancho Senior Center	5.6	1	63001.50284	0%
Deerfield Community Center	6.9	0	276692.3204	1%
Lakeview Senior Center	6.1	1	431451.7426	1%
Cypress Community Center	4.2	4	150890.9727	5%
Trabuco Center	7.3	3	359486.0149	5%
Woodbury Community Center	4.5	6	359486.0149	5%
Heritage Community Center	6.0	1	276692.3204	1%
Harvard Community Center	7.2	0	210518.3343	2%

Table 12: Priority EVI Score for Title 1 Schools

Title 1 Schools				
Location Name	Priority for EVI Score	EVI within 1 KM	2050 VMT	Census Tract EV Market Share
Culverdale Elementary	7.0	0	237498.7611	1%
Cypress Village Elementary	3.3	5	150890.9727	5%
Deerfield Elementary	6.9	0	276692.3204	1%
Eastshore Elementary	7.4	0	431451.7426	1%
Greentree Elementary	5.0	2	276692.3204	1%
Meadow Park Elementary	7.1	0	431451.7426	1%
Northwood Elementary	8.0	2	393025.5027	5%
Oak Creek Elementary	5.1	3	344825.2264	2%
Springbrook Elementary	7.2	0	431451.7426	1%
University Park Elementary	6.9	0	123226.8397	2%
Westpark Elementary	-4.6	12	237498.7611	1%
Cadence Park K-8	11.4	0	380994.5915	7%

Title 1 Schools				
Location Name	Priority for EVI Score	EVI within 1 KM	2050 VMT	Census Tract EV Market Share
Plaza Vista K-8	6.0	1	109287.878	2%
Lakeside Middle School	7.5	0	431451.7426	1%
South Lake Middle School	7.1	0	431451.7426	1%
Venado Middle School	6.9	0	276692.3204	1%

EVI Scores for ZIP Code 92618 Parcels of Interest

Additionally, CSE analyzed parcels in ZIP code 92618, which is considered disadvantaged per CalEnviroScreen, to assess future EVI needs. Parcels that are contiguous are part of the same parcel tract. Here we analyze medium-high residential and apartment parcels because they are of the highest density residential available. One medium-high parcel tract in Portola Springs and several parcel tracts in Oakcreek were of highest priority (Table 13). Apartment complexes Solaira at Pavilion Park in Great Park, Portola Place Apartments in Portola Springs, and a few apartments in Oakcreek are in most need of future EV chargers (Table 14).

Table 13: Priority EVI Score for Medium- to High-Density Residential Parcel Tracts in Irvine

Medium-High Density Residential					
Locale	Parcel Tract Number	Priority for EVI Score	EVI within 1 KM	TAZ VMT (2050)	Census Tract EV Market Share
Portola Springs	17633	9.1	0	213971	7%
Oakcreek	15792	8.8	0	344825.2	2%
Oakcreek	15559	7.7	5	344825.2	2%
Oakcreek	15843	7.7	5	344825.2	2%
Oakcreek	35431-LL	7.7	5	344825.2	2%
Oakcreek	15843	7.5	6	344825.2	2%
Oakcreek	15852	7.5	6	344825.2	2%
Oakcreek	15843	7.2	7	344825.2	2%
Oakcreek	15939	7.0	8	344825.2	2%

Table 14: Priority EVI Score for Apartment Locations in Irvine

Apartments						
Name	**Locale**	**Parcel Tract Number**	**Priority for EVI Score**	**EVI within 1 KM**	**TAZ VMT (2050)**	**Census Tract EV Market share**
Solaira at Pavilion Park	Great Park	17467	9.6	0	380994.6	7%
-	Portola Springs	17757	9.6	0	380994.6	7%
Portola Place Apts.	Portola Springs	16780	9.1	0	213971	7%
Shadow Oaks Apts.	Oakcreek	99-131	8.8	0	344825.2	2%
Brittany Apts.	Oakcreek	15177	8.8	0	344825.2	2%
Sonoma Apts.	Oakcreek	15177	8.8	0	344825.2	2%
Esperanza Apts.	Woodbury	17121	8.0	6	359486	5%
-	Los Olivos	18132	7.6	4	50522.55	3%

VII. EV and EVI Cost Analysis

Table 15 shows the estimated costs to the city for EVs through FY 2028 ($2,017,087). The current market for vehicle purchase is distorted, so current prices may not necessarily reflect prices expected throughout the long-term recommendations of this report. Also, funding opportunities can be advantageous in reducing the cost of fleet transition for both vehicles and infrastructure. These funding strategies also prioritize infrastructure investments and short-term light-duty vehicle replacements due to the similar cost range of ZEV and combustion vehicles, availability of state and federal rebates, and lower cost infrastructure needed to charge or refuel light-duty (LD) vehicles compared to medium-duty/heavy-duty (MDHD) vehicles. However, they are subject to change and are not a guarantee.

Table 15. Estimated Cost of Recommended EVs to FY 2028

Quantity	Make & Model	MSRP	CVRP	CCFR**	HVIP***	Tax Credit*+	Total Incentives	Cost with Savings per Vehicle	Total Cost
2	Chevrolet Bolt EUV	$33,500	$2,000	$750	N/A	N/A	$2,750	$30,750	$61,500
2	Chevrolet Bolt EV	$31,500	$2,000	$750	N/A	N/A	$2,750	$28,750	$57,500
1	Chrysler Pacifica PHEV	$43,655	$1,000	$750	N/A	$7,500	$9,250	$34,405	$34.405
2	Club Car Carryall 300e	$9,944	N/A	N/A	N/A	N/A	N/A	N/A	$19,888
2	Club Car Carryall 500e	$11,763	N/A	N/A	N/A	N/A	N/A	N/A	$23,526
4	Club Car Carryall 700e	$14,856	N/A	N/A	N/A	N/A	N/A	N/A	$59,424
3	Club Car Transporter	$14,430	N/A	N/A	N/A	N/A	N/A	N/A	$43,290
2	Ford Escape PHEV	$33,540	$1,000	$683	N/A	$6,843	$8,526	$25,014	$50,028
4	Ford E-Transit	$43,295	$2,000	$750	N/A	$7,500	$10,250	$33,045	$132,180
6	Ford F-250e	This Make and Model is not release yet so the applicable incentives are unknown at this time.							
14	Ford Lightning	$39,974	$2,000	$750	N/A	$7,500	$10,250	$29,724	$416,136
3	Hyundai Ioniq 5	$39,995	$2,000	$750	N/A	$7,500	$10,250	$29,745	$89,235
1	Hyundai Santa Fe PHEV	$39,500	$1,000	$658	N/A	$6,587	$8,245	$31,255	$31,255
2	Hyundai Tucson PHEV	$34,900	$1,000	$658	N/A	$6,587	$8,245	$26,655	$53,310

Quantity	Make & Model	MSRP	CVRP	CCFR**	HVIP***	Tax Credit*+	Total Incentives	Cost with Savings per Vehicle	Total Cost
3	KIA EV-6	$44,000	$2,000	$750	N/A	$7,500	$10,250	$33,750	$101,250
5	GreenPower Motor Company EV Star	$180,000	N/A	N/A	$60,000	N/A	$60,000	N/A	$600,000
5	Lightning eMotors T350e	TBD	N/A	N/A	$45,000	N/A	$60,000	N/A	TBD
2	Toyota RAV4 PHEV	$39,800	$1,000	$750	N/A	$7,500	$9,250	$30,550	$61,100
6	Volkswagen ID.4	$40,760	$2,000	$750	N/A	$7,500	$10,250	$30,510	$183,060
								TOTAL	**$2,017,087**

* CVRP – Clean Vehicle Rebate Program (California): Rebate amount declines every few years; limited to a total of 30 rebates/calendar year.
** CCFR – California Clean Fuel Reward: Varies w/size of battery; rebate is at point of sale if purchased/leased from dealer; may not be available if leased from nontraditional source.
***HVIP – Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (California): More funds expected in early 2022.

*+ Part of tax credit: Typically only available if leased from nontraditional source; tax credit should be a separate line on bid page.

As previously mentioned, the present EV market may not be an accurate reflection of costs to expect in the future. Current market slowdowns in supply chains, lack of available batteries and chips, and COVID-19 pandemic delays make the conditions at the time of this report's release unfamiliar territory. While it is expected that prices of all types of vehicles will increase in the future, a shift in technology is also anticipated. Although availability of vehicles and lack of discounts for fleet purchasing may currently be barriers to the city's ZEV plan, these hurdles are expected to change in the near future. While production may currently be constrained, future regulation ensures that every manufacturer will produce an increasing percentage of their vehicle production as ZEVs.

Beyond upfront costs, ZEVs reduce maintenance costs (no oil changes, filters, or spark plugs), and thus cost less to operate than internal combustion engine vehicles. The largest savings may be in fuel costs, which are shifted to the cost of electricity instead of gasoline (Consumer Reports, 2020). Provided that the city manages the charging time of fleet vehicles, fueling cost per mile could be half the cost of gasoline (DOE, 2021).

CSE analyzed energy consumption and cost if the city completely replaced their current fleet with EVs and found that the city could expect to pay $124,924 per year (Table 16). Energy impacts and energy costs were based on the average SCE EV-TOU-8 tariff, which is $0.34/kWh and does not consider any additional utility fees/costs associated with increased electric demand. Energy consumption was calculated using the average vehicle mileage of 7,210 miles per year for city vehicles (Appendix A). Additionally, energy consumption per mile for light-duty vehicles, Class 1, sedans, and SUVs was assumed to be 0.28kWh/mile based on an average of commonly available 2021 EV models. Added demand was calculated by assuming an average of 1.3 kW per vehicle (derived from load profile made for local government). Please note that the estimates provided in Table 16 are a high-level estimate based on an average electricity cost. The Distributed Energy Resources (DER) Implementation Plan uses more specific electricity costs and goes into a greater level of detail. Table 16 is intended to provide a general sense of what added electrical load may cost the city, but please refer to the DER Implementation Plan for a more comprehensive analysis.

This assessment is based on the city continuing to receive electricity through SCE, but if the city joins the new community choice aggregator (CCA), Orange County Power Authority (OCPA), this will have little to no impact on the city's electricity costs. The city has already opted for the cleanest electricity which carries a premium and in the coming decade the city will be using a lot more electricity as roughly demonstrated in Table 16. Simultaneously though the city will be reducing its use of gasoline and diesel fuel so the cost impact for "fuel" whether it be gasoline or electricity should remain near current levels. Additionally, even if the city joins the CCA, the city is still eligible for SCE's EVI Charge Ready Programs.

Table 16. Estimated Electrical Load of EVs Recommended for Replacement

Fiscal Year (FY)	EVs purchased	Added Energy Consumption (kWh)	Added Demand (kW)	Added Annual Utility Costs
2023-24	10	20,188	13	$6,864
2023-24	7	14,132	9	$4,805
2024-25	2	4,038	3	$1,373
2025-26	16	32,301	21	$10,982
2026-27	32	64,602	42	21,965
2027-28	42	84,790	55	$28,829
Beyond 2028	45	90,846	59	30,888
Overdue	28	56,526	36	19,219
Total	**182**	**367,423**	**238**	**$124,924**

For EVI, the city should estimate paying at least $1,692,210 upfront to support the planned EVs (Table 17). EVI will need to be installed prior to the purchase of EVs at scale. The city will need to budget this funding in advance of EV replacement funding.

Table 17. Estimated Cost of EVI by Number of Ports Recommended

Term	Quantity of Ports	Type of Charger	Average Initial Project Cost per Port*	Average CALeVIP Rebate per Port*	EnergIIZE*	Cost to City
Near	32	Dedicated 120v Outlets	$3,000	-		**$96,000**
	41	Level 2	$9,292	$4,224	-	**$207,788**
	12	DCFC	$103,027	-	$51,514	**$618,156**
Mid	91	Level 2	$9,292	$4,224	-	**$461,188**
	6	DCFC	$103,027		$51,514	**$309,078**
					TOTAL Near-Term	**$921,944**
					TOTAL	**$1,692,210**

* California Electric Vehicle Infrastructure Project (CALeVIP) Cost Data (four chargers estimate); How Much Do EV Charging Stations Cost? Expect $6,000 On Average (propertymanagerinsider.com); Charge Ready estimates were unavailable; EnergIIZE rebates were estimated at 50% of CALeVIP project costs and chargers would need to be at least 150 kW to receive an incentive.

These costs are based upon the use of Fleet EVI. If the EVI will also be available to the public, more expensive equipment is required. Public facing EVI must have credit card readers and require separate network connections. There are a number of differences in the devices used for Fleet charging and Public charging. Recent California Air Resources Board Regulations and Department of Measurements and Standards regulations established requirements for Public EVI. These requirements do not apply to EVI installed exclusively for the city's fleet vehicles. Among other things, Public EVI requires credit card readers. In addition to cost of the card reader, each card reader has its own (separate) cellular modem and a separate network fee. The card reader and the modem add both capital costs and ongoing monthly costs, whether or not the credit card reader is used.

The newest public Level 2 EVSE, similar to those at City Hall, have credit card readers. These EVSE cost more than $6,000 each and have two network modems and two monthly network fees – one for the EVSE (usage and management) and the second (billing) network for the credit card reader. The same firm makes a utilitarian EVSE for Fleet applications which costs less than $2,000. If the EVSE are being installed for the City's Fleet vehicles, the cty is encouraged to consider procuring the less costly Fleet EVI.

Additionally, networking the city's charging stations will be important. Networking will provide access control, manage the city's charging and energy costs, and ensure eligibility for the State's Low Carbon Fuel Credits (LCFS). The cost of networking varies significantly from network (system provider) to network and can be as much as $500 per port per year (~$91,000 more). Non-networked chargers provide charging, but do not limit access, or manage charging to minimize the city's costs. While non-networked EVSE are initially the less expensive option, there are unique advantages to networking, such as the ability to manage costs, restrict access, or create reports about station usage or GHG emissions avoided. Non-networking EVSE will make it far more difficult for the city to earn LCFS.

Finally, while fuel, maintenance, and operational costs for EVs will be about half the costs for similar petroleum-fueled vehicles, maintenance and networking costs for the city's EVI is anticipated to increase over time. Additionally, the city's electricity costs will increase significantly compared with the current budgeted amount. However, there should also be a corresponding decline in the city's gasoline budget. The city should expect that its annual maintenance and networking costs for its EVI be about 10% of its overall EV/EVI capital budget. (If the EVI capital budget is $1.7 million, maintenance and networking costs would be about $170,000 per year.) Networking the city's EVI also enables eligibility for the State's LCFS program. The LCFS program represent a substantial revenue stream which could more than offset the city's EVI's networking, maintenance, and repair costs. Several networks will process the city's LCFS as part of their service. The city should explore these opportunities and require a strict accounting of the LCFS earned, their sales price, and the network and maintenance offset.

VIII. Funding Opportunities

Funding strategies can offset the additional costs of transitioning a fleet to EVs consistent with the vehicle, infrastructure, and workforce recommendations offered in earlier sections. The proposed potential funding opportunities evaluated include the following.

- Light-Duty Vehicles
  - Clean Vehicle Rebate Project for Fleets (CVRP)
  - California Clean Fuel Reward Program (CCFR)
  - Federal tax credit – EV Smart Fleets case study
  - Lease options
- Medium- and Heavy-Duty Vehicles
  - Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
- Infrastructure
  - Low Carbon Fuel Standard (LCFS)
  - Charge Ready
  - California Electric Vehicle Infrastructure Project (CALeVIP)
  - Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE)
  - California Lending for Energy and Environmental Needs (CLEEN)

This analysis will also include consideration of funding opportunity terms, such as requirements for public access that may make certain sources of funding limiting in value or applicability. The funding opportunities listed below are a high-level summary of options available and suggested to the city. Further analysis may be needed to determine which options are most appropriate for city needs.

Potential New Funding Opportunities – Light-Duty Vehicles

Clean Vehicle Rebate Project for Fleets

The Clean Vehicle Rebate Project (CVRP) currently offers up to $7,000 for the purchase or lease of eligible ZEVs for public agencies — up to 30 rebates a year (Table 18).

To help with planning and budgeting, public fleets are eligible to reserve rebate funds up to 18 months prior to vehicle purchase by submitting supporting documentation. Vehicles must be on the CVRP list of eligible vehicles, new at the time of lease or purchase, and registered in California and owned, operated, and registered in the state for a minimum of 30 months. Original lease terms must be for a minimum of 30 months.

Public fleets must submit annual vehicle usage reports to the CVRP administrator (CSE) for all rebated vehicles 12, 24, and 30 months following the date of asset delivery. Required data may include, but is not limited to, mileage reporting, annual fuel use by fuel type, and percentage of operation within underserved communities.

Table 18. Clean Vehicle Rebate Project Incentives

Vehicle Type	Standard Rebate	Increased Rebate
Fuel Cell EV	$4,500	$7,000
Battery EV	$2,000	$4,500
Plug-in Hybrid EV	$1,000	$1,500

Fleet vehicles domiciled at a facility within the boundaries of a ZIP code containing at least one "disadvantaged community" (DAC) census tract, as identified by the California Environmental Protection Agency, are eligible for an increased rebate. For the city, the ZIP codes eligible for a public fleet increased rebate include 91910, 91911, 91950, 92020, 92101, 92102, 92105, 92113, 92136, and 92173.

California Clean Fuel Reward Program

The California Clean Fuel Reward Program (CCFR) offers up to $750 for the purchase or lease of eligible BEVs and PHEVs with a battery capacity of 5 kWh or greater. The reward is offered on a sliding scale, depending on battery size.

Unlike CVRP, there is no limit on the number of rewards a fleet could receive on an annual basis. Whereas CVRP is a post-purchase rebate and there is no limit on which California dealership a vehicle is purchased from, the CCFR reward is offered at the point of sale by retailers who are enrolled in CCFR. While CCFR does not offer an increased rebate option like CVRP, there is also no reporting requirement as there is for CVRP.

Federal Income Tax Credit – EV Smart Fleets Case Study

BEVs and PHEVs purchased new may be eligible for a federal income tax credit (FTC) of up to $7,500. The credit amount will vary based on the capacity of the battery used to power the vehicle.

Auto manufacturers are allotted quotas of tax credits. Once the volume of tax credits claimed exceed the manufacturers' quota, a year-long phase out process is initiated where the amount of the eligible tax credit is reduced to 50% and then 25% before zeroing out. Tesla and General Motors have exceeded their quota; their models are no longer eligible for the federal EV tax credit.

On their own, the city is ineligible for the FTC. However, in April 2017, EV Smart Fleets released a case study on multiple local governments who jointly procured EVs and realized the full benefit of the FTC. The case study serves as a blueprint for how the City of Irvine can take advantage of the largest funding opportunity available to public fleets for the purchase of EVs.

EV Smart Fleets reports in the case study (see link above) that the City of Alameda led a collective EV purchase of 90 EVs for 10 public fleets. The procurement resulted in the purchase of 64 Ford Focus and

23 Nissan LEAF. The jurisdictions also conducted procurements for EV charging stations and charging station installations.

Alameda created a single bid process for the aggregated procurement, evaluated the bids received, and designated the qualified bidder with the lowest price for each of the specified vehicles. Each participating agency then awarded purchase contracts to the winning bidder based on the accepted bid price. The solicitation encouraged dealerships to take advantage of the federal EV tax credit and pass on the value of this credit through a line-item discount into the final bid price. One bidder included the full value of the federal tax credit — a discount of $7,500 per vehicle — and was ultimately declared the lowest bidder.

The procurement process was successful in attracting bids from local vendors for the purchase of EVs, while reducing vehicle purchase administrative costs for participating fleets. The model was considered so effective that it was subsequently used for future procurements.

Federal Tax Credit: Patience is a Virtue (maybe)

The EV Smart Fleet approach for realizing the benefit of the FTC is a significant change for public fleets. Taking advantage of the federal tax credit reduces the MSRP of some EVs below that of a comparable gas model, which the state incentives alone cannot accomplish.

Furthermore, the federal tax credit may soon become even more compelling. President Biden's Build Back Better (BBB) proposal includes two key provisions that enhance the current FTC: first, Tesla and GM models would be made eligible again; second, a $4,500 adder is proposed for models manufactured in the U.S. with a union workforce, which would apply to Ford, GM, and Stellantis (formerly Fiat Chrysler) for the near future. With a $12,000 federal tax credit, plus CVRP and CCFR incentives, the Chevy Bolt EV, Chevy Bolt EUV, and Ford Escape PHEV would be thousands of dollars less than the comparable gas alternative; and the Chrysler Pacifica would be less than $1,000 more than the gas-powered Ford Transit.

Given a revamped FTC would turn the "EVs have a higher capital cost" narrative on its head for some models, the city may want to delay procurement decisions until Q2 2022 when the future of the FTC is clearer.

Bid Process: Two Birds, One Stone

As a bid process a la the EV Smart Fleet approach is necessary to take advantage of the FTC — either in its current iteration or the beefed-up BBB version — the city should also make sure that the bid process explicitly states a preference for bidders who pass on the value of the CCFR to the city through a separate line-item discount, in addition to the FTC, into the final bid price. This would mean the successful bidder would either be a dealership participating in CCFR or a third party who would be purchasing from a participating dealership. According to the CCFR website, there are over 100 participating retailers in the city, so this should not be a limiting factor on receiving qualified bids.

Program Funding & Eligibility: The Only Constant is Change

One of the more challenging and enduring aspects of assessing these incentive programs is the fluid nature of funding availability, incentive amount, and incentive eligibility.

- As mentioned, the FTC could be welcoming Tesla and GM models back into the program AND offering a $4,500 adder for qualifying automakers, pending action by the U.S. Senate.
- Until early November 2021, the CCFR offered a maximum incentive up to $1,500, but was reduced to $750 due to demand for the reward outpacing the utility funding source. No advance notice was provided about the reduction, what triggered the reduction, or the present status of the funding source, so it is difficult to predict what the value of the CCFR will be in the future.
- Regarding CVRP, CARB just voted to phase out PHEVs from incentives entirely and reduce the rebate amount by $500 for BEVs in 2023. Furthermore, while funding for the program should be secure through June 2024, the Legislature has a lengthy history of dictating program rules via both the budget process and policy bills.

This funding analysis reflects programs rules and available incentives as of December 2021. Links have been included to the various programs to not only provide additional background information but so that city decision-makers can easily check the status of key funding opportunities as they are all likely to see some manner of material change(s) in the next 1-3 years.

Even without the BBB version of the FTC, there are BEV and PHEV options in both the sedan and compact SUV classes that are either less than $1,000 greater in upfront capital or less expensive than a gas alternative after incentives. Under the current FTC, the Nissan Leaf has a clear cost advantage over other BEV and PHEV sedans. With an improved range of 226 miles, the MY 2022 Leaf is much more competitive with the Chevy Bolt. If the Biden FTC proposal is adopted, then both the Leaf and the Bolt would save the city over $5,000 per vehicle compared to a gas-powered alternative.

There are a select number of city facilities that are in a DAC ZIP code and therefore eligible for a CVRP increased rebate. For light-duty vehicle replacements at facilities located in a DAC ZIP code — such as Great Park and FivePoint Amphitheater — the city should factor in an additional $2,500 for CVRP-eligible vehicles.

The Hyundai NEXO is included for comparison's sake as one of the few light-duty FCEVs available today. As reflected by the NEXO, the MSRP for FCEVs is prohibitively more expensive than BEV or PHEV alternatives. Unlike BEVs and PHEVs, FCEVs are only eligible for CVRP; while the rebate amount is larger for FCEVs — $4,500 for the standard rebate compared to $2,000 for a BEV and $1,000 for a PHEV — the inability to draw on the FTC and CCFR renders FCEVs much more expensive options. For the near future and absent changes to state and federal incentive programs to bolster incentives, FCEVs simply cannot compete with BEVs and PHEVs in the light-duty vehicle market.

The difference between the Ford Transit Connect and the Ford Transit Wagon is the former is for cargo and the latter is for passengers. In similar fashion, the Ford E-Transit is for cargo and the Chrysler Pacifica is for passengers. Of note, the Ford E-Transit is not eligible for CVRP as it is not a passenger vehicle.

While not listed in the table, the Ford Mach-e would not be eligible for the additional $4,500 FTC adder as it is currently manufactured in Mexico.

Lease Options

Leasing vehicles may be an option that offers advantages to purchasing them. There are several lease options. In a conventional lease, the dealer provides the vehicle for a fixed period at either a fixed monthly, quarterly, or annual cost. Conventional leases are either open-end or closed-end. A third option is a municipal lease.

When could a lease be advantageous to the city?

A lease could be advantageous when the technology is changing rapidly, when the city is unsure of the appropriateness of the vehicle(s) or technology for specific applications, and/or the city is experimenting with various technologies. It can also be a means of taking advantage of unique situations.

For example, the Nissan LEAF Plus is a low-cost EV with a range of 226 miles. Previous model LEAFs have experienced accelerated degradation of their battery packs — especially compared to other affordable ZEVs. If the city could lease these vehicles at below market, the city could return these vehicles at the end of the lease — and avoid any battery degradation issues.

Some makes and/or models may be new to the market, such as the Fisker Ocean or the Lordstown Endurance. Rather than purchasing these new market entrants, the city could lease a few of them to determine whether they should be incorporated into the city's fleet.

If the vehicle is used in a high usage application, an open-end lease is the better option because the city would not be concerned about the mileage limit. This can be a cost-effective alternative if the vehicle does not depreciate more than its guaranteed residual value (GRV).

If the vehicle's usage is within the lease's mileage limits (10,000, 12,000, or 15,000 miles per year), most retail consumers prefer closed-end leases of PHEVs and ZEVs to avoid paying a large lump sum at the end of the lease contract.

Open-end Lease

An open-end lease allows the lessee to guarantee a value at the end of the lease. This is called the guaranteed residual value (GRV) and is outlined in the lease contract. The lessee has the option of purchasing, selling, or trading in the leased vehicle at the end of the contract for the GRV provided the car is worth at least that amount.

If the market value of the vehicle is less than the GRV at the end of the lease, the lessee is responsible for the difference, whether they plan to buy back the vehicle or return it to the lessor. For instance, if the GRV is $10,000 and the market value of the car is only $8,000 at the end of the contract, the lessee will be responsible for paying the difference of $2,000.

In return for bearing the financial risk of the lease, the lessee typically pays a less expensive rate and does not have to worry about a mileage restriction.

Closed-end Lease

Most retail leases are closed-end leases. A closed-end lease is designed to put the cost of depreciation onto the lessor, instead of the lessee. Instead of negotiating a GRV, customers have the option of either returning the car at the end of the lease (assuming it is in good condition) or buying it back from the lessor at the GRV. However, the lessee is responsible for paying for any damage at the end of the lease that goes beyond normal wear and tear. Note: normal "wear and tear" is typically more stringent with a closed-end lease compared to an open-end lease.

Most closed-end leases also have mileage restrictions of 10,000 miles to 15,000 miles per year. If mileage exceeds the annual limit at the end of the lease, there will be a fee per mile for any additional miles — which could be significant. For example:

- Recently, the City of Pasadena leased two Volkswagen I.D.4s. The lease is a three-year closed-end lease with an annual usage of 12,000 miles. The lease includes all maintenance and repairs, excluding accident damage. The finance firm swept the federal tax credit incorporating its value into the final lease cost. The total cost for the three-year lease was $14,000 per vehicle. The city applied for and received the state's $2,000 CVRP for Fleets for each vehicle. After the CVRP rebate, the city's net cost per vehicle is $12,000 or $333 per month. The city pays the lease annually.

Municipal Leases

In addition to the conventional open- and closed-end leases, the city should explore a municipal lease. A municipal lease is a tax advantaged lease (to the lessor) and a tax-exempt lease-purchase agreement. For the city, it is an installment purchase, or a conditional sale or lease with an option for the city to purchase the vehicle at the end of the lease for nominal value (typically $1 per vehicle). A municipal lease offers fixed-rate financing. Payments can be monthly, quarterly, semiannually, or annually. Add-on equipment, upfits — especially for a truck or van — and extended warranty plans can be included.

When is a municipal lease a good option?

A municipal lease can be an attractive option when the city's needs for replacement vehicles exceeds its fixed asset budget. Leasing replacement vehicles and spreading their replacement costs over several years can accelerate the replacement of older, unreliable vehicles and equipment that requires or will require extensive and/or expensive repairs. A municipal lease can significantly reduce the downtime of the fleet's older vehicles and lower the cost of their maintenance and repairs. And unlike a rental vehicle, the city builds equity in the vehicle with its payments. Equity is accumulated with each payment and ownership is realized with a final payment — typically $1 per vehicle at the end of the lease.

- Case Study. During the recession of the early 1990s, a local agency's specialized equipment was well beyond its replacement life; no unit should have been more than 21 years old. The average unit was more than 14 years old, but some units were almost 30 years old. The agency did not have a budget to replace the appropriate number of units scheduled for replacement, let alone those that had not been replaced on schedule and/or those with older designs that presented a safety concern. In its first order, the agency ordered 140 units through a seven-year municipal lease. The agency placed a similar order the following year. The reduction in downtime as well as maintenance and repair costs were dramatic. The agency was able to make its annual lease payments from its savings in maintenance and repair costs. Within two years, breakdowns and road calls were dramatically reduced and uptime improved significantly.

In addition to conventional sources, like Ford Motor Credit Company LLC, General Motors Financial Company, Inc., etc., there are several financial firms such as the Bancorp, Merchants Bank, and Mike Albert Fleet Solutions offering various fleet financing options.

Potential New Funding Opportunities – Medium- and Heavy-Duty Vehicles

Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project

Launched by CARB and administered by CALSTART, the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) provides $20,000 to $40,000 to municipal fleets, depending on vehicles purchased from Class 3-8. Fleet managers do not directly apply for HVIP vouchers, but rather connect with an HVIP-approved dealer to purchase their vehicle(s) and the dealer then acquires the voucher. Incentive amounts are provided to the purchaser, and then the total cost to the fleet is determined by the fleet and the purchaser. A fleet can use up to 30 HVIP vouchers per year. In the past, this program has been oversubscribed on its opening day, so it is suggested to act quickly to acquire this incentive.

Potential New Funding Opportunities – Infrastructure

Low Carbon Fuel Standard (LCFS)

The Low Carbon Fuel Standard (LCFS) incentivizes use of electric and hydrogen technologies in transportation by providing credits that can be traded in the California LCFS credit market.

Charge Ready

The Charge Ready Program and Charging Infrastructure and Rebate Program are available to SCE customers to offset costs of EVI. As a part of this program, SCE performs all necessary infrastructure work on the utility side of the meter, and all participants can also choose to have SCE perform customer-side infrastructure work at no additional cost. Alternatively, applicants may choose to design, procure, install, and maintain the customer-side make-ready infrastructure themselves and qualify to receive a rebate of up to 80% of the estimated costs SCE would incur for performing the work.

Rebates are available for the purchase and installation of four or more L1 or L2 EV charging station ports and/or at least two DCFC ports. This program is available through 2025, or until available funding is fully subscribed. Participants are responsible for purchasing and installing all EV charging equipment and paying all EV charging station energy costs. Applying for Charge Ready should be a priority for the city in order to immediately begin installation of make-ready charging stations. The city should explore the Charge Ready funding as soon as possible to begin the installation of EVSE.

California Electric Vehicle Infrastructure Project

The California Energy Commission's California Electric Vehicle Infrastructure Project (CALeVIP) provides incentives for EV charger installations and works with local partners to develop and implement projects that meet current and future regional EV needs for Level 2 and DC fast charging. The Southern California Level 2 Incentive Project promotes easy access to zero-emission vehicle infrastructure by offering rebates for the purchase and installation of eligible public EV chargers in Los Angeles, Orange, Riverside, and San Bernardino counties — with a total of $23 million in available funds.

Rebates up to $70,000 per DCFC installation are available for new sites and installation sites with stub-outs. Rebates up to $40,000 per DCFC installation are available for replacement and make-ready sites. For sites in DACs, eligible rebates are up to $80,000 per DC fast charger regardless of installation site type.

Final rebate amounts are determined by the total eligible project costs. Rebates for non-DAC applications are calculated up to $70,000 per DCFC or 75% of total project cost, whichever is less. For DAC applications, rebates are calculated up to $80,000 per DCFC or 80% of total project cost, whichever is less. CALeVIP rebates are eligible for charging infrastructure that is publicly available 24 hours a day, year-round. CSE is the CALeVIP administrator.

Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles

Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) provides funding for electric vehicle charging and hydrogen refueling infrastructure for zero-emission trucks, buses, and equipment in California.

There are four unique funding lanes under EnergIIZE. An applicant may only apply once per funding lane wave. For instance, under EV Fast Track, an applicant may apply once during the open window of that lane. The amount of eligible funding also varies depending on the funding lane. Project caps range from $500,000 for electric charging infrastructure to $2 million for hydrogen fueling, with increased incentives available to applicants meeting equity criteria ($750,000 for electric charging and $3 million for hydrogen fueling, respectively).

California Lending for Energy and Environmental Needs

The California Lending for Energy and Environmental Needs (CLEEN) Center offers two programs: Statewide Energy Efficiency Program and Light Emitting Diode Street Lighting Program. Financing can be through a direct loan from IBank in amounts from $500,000 to $30 million. Statewide energy efficiency projects include comprehensive efficiency improvements to new and existing facilities that save energy, such as ZEV, energy management systems, and hydrogen fueling stations.

IX. Plan Monitoring

Table 19 summarizes report strategies and actions by fiscal year and then the responsible city department for each task. It is recommended that the city hold a meeting across impacted departments to determine the responsible department for each action item outlined below.

Table 19. ZEV Plan Action Items with Responsible Department

FY	Strategies	Actions
2023	1. Adopt ZEV Vehicle Replacement Policy 2. Budget for EV and EVI in FY 2024-25 3. Review existing maintenance contracts and develop strategy for adapting maintenance plans as necessary to support electrifying fleet. 4. Develop EVI assistance program for community EVI and determine key performance indicators to track program performance	1a. Draft policy that establishes procedure for low-use vehicles and a 100% light-duty ZEV purchase requirement and at least a 50% Class 2 (¾-ton pickups and vans) through Class 8 medium-duty/heavy-duty purchase requirement for ZEV from FY 2024 to FY 2026, as well as a 100% ZEV purchase requirement in FY 2027, this includes Class 5-8 trucks 1b. Present policy to city council and make adjustment if needed 2a. Use EV estimates in Table 14 and Appendix B, and EVI estimates in Table 5 and Table 16 to budget for improvement in FY 2024 4a. Use community analysis results to inform if additional areas of the city are in need EVI assistance and develop program to address those needs

FY	Strategies	Actions
2024	5. Conduct OSF and Civic Center site assessments and begin request for proposal (RFP) process for EVI (installation of EVI can take 12-15 months) Request fleet management capabilities 6. Meet with SCE utility account manager to discuss EVI demand changes and EV rates 7. Select EVI contractor, purchase equipment, purchase fleet management platform and network platform, and pay and conduct installation 8. Adopt a fleet management policy for EVs and EVI equipment 9. Determine if EVs will be leased or bought through a third party 10. Purchase EVs according to Appendix B for FY 2024 11. Apply for EV and EVI incentives 12. Implement Community EVI and evaluate success	5a. Draft RFP for proposed EVI (included installation phasing for near-term and midterm EVI, networking, and fleet management goals) 5b. Determine if city of contractor will receive LCFS credits and apply for incentives 6a. Use final site assessments to determine required electric demand 7a. Issue RFP, receive bids, select contractor, and install 8a. Verify ZEVs incentives available and purchasing options Refer to funding list in report and begin applying for available EV and EVI incentives (city or contractor)
2025	13. Purchase EVs according to Appendix B for FY 2025. 14. Apply for EV incentives 15. Implement community EVI and evaluate success 16. Budget for EVs in FY 2026-27	13a. Replacement should focus on Class 1 (sedans, SUVs, half-ton pickup trucks) and Class 2-4 (heavier trucks and vans, those with a gross vehicle weight rating of up to 14,000 lbs., 15-passenger youth vans and TRIPs shuttles)
2026	17. Purchase EVs according to Appendix B for FY 2026 18. Apply for EV incentives 19. Implement community EVI and evaluate success	17a. Replacement should focus on Class 1 (sedans, SUVs, half-ton pickup trucks) and Class 2-4 (heavier trucks and vans, those with a gross vehicle weight rating of up to 14,000 lbs., 15-passenger youth vans and TRIPs shuttles)
2027 & Beyond	20. Purchase EVs according to Appendix B for FY 2027 21. Apply for EV and EVI incentives	20a. City should start replacing larger Class 5-8 trucks as ZEVs unless there is not an appropriate ZEV replacement

FY	Strategies	Actions
	22. Determine EV replacements beyond FY 2027	
Annual	ADMIN. Continually revise fleet listing spreadsheet	ADMINa. Make additional column (s) for tracking ZEV vehicles ADMINb. Note any vehicles with low mileage or usage and determine if vehicle is still needed

X. Conclusions and Next Steps

The City of Irvine will need to invest about $3.8 million over the next four years in EVs and EVI for both fleet and community to both meet existing and pending state regulations and to provide adequate infrastructure to its constituents. For the city's fleet, investment in EVI will need to come first as it takes 12-15 months to install infrastructure. EVs cannot be used to satisfy the city's needs until infrastructure is in place, and the city will need to install about 137 chargers by FY 2028. The investment in city EVs will need to closely follow starting with Class 1 to 4 vehicles that are up for replacement in FY 2024 and then replacing Class 5-8 vehicles as suitable replacements become available (replacement of about 182 vehicles beyond FY 2030). Additionally, the city should look to phase out RNG vehicles when considering replacements in the next five years as this is when the city's fueling contract will be due for renewal again.

On a community level, the city will need to encourage and potentially develop an assistance program for public EVI. Locations that should be of high interest to the city to install public infrastructure are Northwood High School, Portola High School, Portola Springs Community Center, Cadence Park School, Northwood Elementary, Cadence Park K-8 School, Apartment complexes Solaira at Pavilion Park in Great Park, Portola Place Apartments in Portola Spring, and a few apartments in Oakcreek. Moving forward on public EVI, the city may want to consider public locations that were not evaluated as part of this project such as shopping centers and malls adjacent to existing significant multi-family developments.

This project report will be followed next by a distributed energy resource (DERs) analysis, which will investigate how adding DERs, such as solar and grid management devices, would be able to be interwoven with EVs and EVI. The next report will also evaluate the impact DERS would have on accounting for additional electricity consumption from EV/EVI and offsetting energy costs.

Appendix A – Fleet and EVI Analysis Workbook

Attachment: Appendix A – Fleet and EVI Analysis Excel Workbook

Appendix B – 1:1 Fleet Replacement Schedule

	Existing Fleet							Replacement Suggestion			
Replacement FY	**Vehicle No.**	**Year**	**Make**	**Model**	**Class**	**Duty**	**Location**	**Year**	**Make**	**Model**	**Duty**
Overdue	1034	2007	FORD	E350 15 Passenger Van	Van - Specialty	MD	Civic Center	2024	Lightning eMotors	T350e	MD
Overdue	1052	2008	FORD	Taurus	Car - Full Size	LD	OSF	2022	Hyundai	Ioniq-5	LD
Overdue	1055, 1056	2008	FORD	Escape	SUV - Compact	LD	Civic Center	2022	Ford	Escape PHEV	LD
Overdue	1066	2008	FORD	Explorer Sport Utility	SUV - Full Size	LD	OSF	2022	Hyundai	Tucson PHEV	LD
Overdue	1092, 1093	2008	FORD	F250 Series	Truck - Full Size	MD	OSF	2026	Ford	F-250e	MD
Overdue	1095	2009	FORD	Edge SUV	SUV - Compact	LD	OSF	2022	Hyundai	Tucson PHEV	LD
Overdue	1114	2010	FORD	F250 Series	Truck - Full Size	MD	Civic Center	2026	Ford	F-250e	MD
Overdue	1119	2009	FORD	F250 Series	Truck - Full Size	MD	OSF	2026	Ford	F-250e	MD
Overdue	1127	2010	CLUB CAR	Club Car	Cart	LD	OSF		CLUB CAR	Club Car E	LD
Overdue	1172	2012	FORD	F250 Series	Truck - Full Size	MD	Civic Center	2026	Ford	F-250e	MD
Overdue	1197	2013	FORD	E350 15 Passenger Van	Van - Specialty	MD	TRIPS / OSF	2024	Lightning eMotors	T350e	MD
Overdue	1228	2014	FORD	E350 15 Passenger Van	Van - Specialty	MD	Woodbury CP	2024	Lightning eMotors	T350e	MD
Overdue	1229, 1230	2014	FORD	E350 15 Passenger Van	Van - Specialty	MD	MSP-Youth/ Heritage Park	2024	Lightning eMotors	T350e	MD
Overdue	1231	2014	FORD	E350 15 Passenger Van	Van - Specialty	MD	Heritage CP	2024	Lightning eMotors	T350e	MD
Overdue	1236	2014	FORD	Fusion	Car - Compact	LD	Civic Center	2022	KIA	EV-6	LD
Overdue	1238	2014	TOYOTA	Prius	Car - Compact	LD	Civic Center	2022	Chevrolet	Bolt EV	LD
Overdue	1297	2016	TOYOTA	Tacoma	Truck - Compact	LD	Civic Center	2023	Ford	Lightning	LD
Overdue	1314, 1315	2016	FORD	E450 Glaval 12 Passenger	Van - Specialty	MD	TRIPS / OSF	2022	Lightning eMotors	E450	MD
Overdue	1406	2017	FORD	E450 Glaval 12 Passenger	Van - Specialty	MD	TRIPS / OSF	2022	Lightning eMotors	E450	MD
Overdue	1413	2017	FORD	E450 Glaval 12 Passenger	Van - Specialty	MD	Animal Services / OSF	2022	Lightning eMotors	E450	MD
Overdue	14035, 14103, 14105	2014	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
Overdue	15102	2015	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Toyota	RAV4 PHEV	LD
22-23	1030, 1031	2007	FORD	Explorer	SUV - Full Size	LD	OSF	2022	Hyundai	Santa Fe PHEV	LD

	Existing Fleet							Replacement Suggestion			
Replacement FY	Vehicle No.	Year	Make	Model	Class	Duty	Location	Year	Make	Model	Duty
22-23	1072	2008	FORD	Escape	SUV - Compact	LD	Civic Center	2022	Ford	Escape PHEV	LD
22-23	1132	2011	FORD	Escape	SUV - Compact	LD	OSF	2022	Chevrolet	Bolt EUV	LD
22-23	1266	2015	FORD	Explorer	SUV - Full Size	LD	OSF	2022	Toyota	RAV4 PHEV	LD
22-23	1311, 1390	2016	CLUB CAR	Club Car	Cart	LD	Civic Center / OSF		CLUB CAR	Club Car E	LD
22-23	1411, 1412	2017	CLUB CAR	Club Car	Cart	LD	Civic Center		CLUB CAR	Club Car E	LD
22-23	18048	2017	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
23-24	1254	2014	TOYOTA	Prius	Car - Compact	LD	Civic Center	2022	Chevrolet	Bolt EV	LD
23-24	1275	2015	TOYOTA	Camry	Car - Full Size	LD	OSF	2022	Hyundai	Ioniq-5	LD
23-24	1278	2014	TOYOTA	Camry	Car - Full Size	LD	OSF	2022	KIA	EV-6	LD
23-24	1378, 1379, 1380	2017	TOYOTA	Tacoma	Truck - Compact	LD	OSF	2023	Ford	Lightning	LD
23-24	15015	2015	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
24-25	1527, 1528	2017	FORD	Ford F-450 Starcraft	TRIPS Bus	MD	OSF	2023	Lightning eMotors	E450	MD
25-26	1249, 1250, 1251, 1252, 1255, 1256, 1257, 1258	2014	FORD	F150 Series	Truck - Full Size	LD	Civic Center	2023	Ford	Lightning	LD
25-26	1259	2015	FORD	Cargo Transit	Van - Compact	LD	OSF	2022	Lightning eMotors	E450	MD
25-26	1264	2014	TOYOTA	Sienna	Van - Midsize	LD	TRIPS / OSF	2022	Chrysler	Pacifica PHEV	LD
25-26	1271	2015	TOYOTA	Tacoma	Truck - Compact	LD	OSF	2023	Ford	Lightning	LD
25-26	1392	2017	TOYOTA	Camry	Car - Full Size	LD	OSF	2022	Hyundai	Ioniq-5	LD
25-26	1562, 1563, 1564	2019	FORD	Ford E450 Glaval ADA Shuttle	TRIPS Bus	MD	OSF	2022	Lightning eMotors	E450	MD
25-26	17022	2017	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
26-27	1289	2015	FORD	Transit 250	Van - Midsize	MD	OSF	2023	Ford	e-Transit	LD
26-27	1296	2015	FORD	F150 Series	Truck - Full Size	LD	OSF	2023	Ford	Lightning	LD
26-27	1307, 1310	2015	TOYOTA	Tacoma	Truck - Compact	LD	OSF	2023	Ford	Lightning	LD
26-27	1316	2016	FORD	F250 Series	Truck - Full Size	MD	OSF	2026	Ford	F-250e	MD
26-27	1317, 1319, 1322, 1324	2016	TOYOTA	Tacoma	Truck - Compact	LD	OSF	2023	Ford	Lightning	LD

	Existing Fleet							Replacement Suggestion			
Replacement FY	Vehicle No.	Year	Make	Model	Class	Duty	Location	Year	Make	Model	Duty
26-27	1326, 1330	2016	FORD	Transit 150	Van - Compact	LD	OSF	2023	Ford	e-Transit	LD
26-27	1328	2016	FORD	F150 Series	Truck - Full Size	LD	Civic Center	2023	Ford	Lightning	LD
26-27	1329	2016	TOYOTA	Sienna	Van - Midsize	LD	OSF	2023	Ford	e-Transit	LD
26-27	1331, 1332	2016	TOYOTA	Tacoma	Truck - Compact	LD	Civic Center	2023	Ford	Lightning	LD
26-27	1339, 1340, 1344	2016	FORD	F150 Series	Truck - Full Size	LD	OSF	2023	Ford	Lightning	LD
26-27	1445	2018	FORD	Hybrid Fusion	Car - Full Size	LD	Civic Center	2024	Chevrolet	Bolt EUV	LD
26-27	1451	2018	CLUB CAR	Transporter	Cart	LD	OSF		CLUB CAR	Transporter Electric	LD
26-27	1450, 1452, 1453, 1454, 1455	2018	CLUB CAR	Carryall 300	Cart	LD	OSF		CLUB CAR	Carryall 300e	LD
26-27	1556, 1566, 1567, 1568, 1569	2021	CLUB CAR	Carryall 300 E	Cart	LD	OSF	2021	CLUB CAR	Carryall 300 E	LD
26-27	16054	2016	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
26-27	18062	2017	FORD	Explorer	SUV - Full Size	LD	Civic Center	2022	Volkswagen	I.D. 4	LD
27-28	1352, 1353, 1354, 1365, 1366, 1367, 1368, 1369, 1370, 1371, 1372, 1373, 1374, 1375, 1376, 1377, 1383	2016	FORD	F150 Series	Truck - Full Size	LD	Both	2023	Ford	Lightning	LD
27-28	1362, 1364	2016	FORD	F250 Series	Truck - Full Size	MD	Both	2026	Ford	F-250e	MD
27-28	1388, 1389	2017	TOYOTA	Tacoma	Truck - Compact	LD	OSF	2023	Ford	Lightning	LD
27-28	1393	2017	FORD	F150 Series	Truck - Full Size	LD	Civic Center	2023	Ford	Lightning	LD
27-28	1395	2017	FORD	Transit	Van - Compact	MD	OSF	2023	Ford	e-Transit	LD
27-28	1400, 1401	2017	FORD	Transit 250 Series	Van - Compact	MD	OSF	2024	Lightning eMotors	T350e	MD
27-28	1460	2018	TOYOTA	Camry	Car - Full Size	LD	OSF	2022	KIA	EV-6	LD
27-28	1461	2018	CLUB CAR	Carryall 700	Cart	LD	OSF		CLUB CAR	Carryall 700e	LD

	Existing Fleet							Replacement Suggestion			
Replacement FY	Vehicle No.	Year	Make	Model	Class	Duty	Location	Year	Make	Model	Duty
27-28	1462	2017	CLUB CAR	Carryall 700	Cart	LD	OSF		CLUB CAR	Carryall 700e	LD
27-28	1469	2018	CLUB CAR	Carryall 500 Gas	Cart	LD	OSF		CLUB CAR	Carryall 500e	LD
27-28	1470, 1471	2018	CLUB CAR	Carryall 700 Gas	Cart	LD	OSF		CLUB CAR	Carryall 700e	LD
27-28	1472, 1475	2018	CLUB CAR	Transporter Electric	Cart	LD	OSF	Cart	CLUB CAR	Transporter Electric	LD
27-28	1474, 1476	2018	CLUB CAR	Carryall 500e	Cart	LD	OSF	Cart	CLUB CAR	Carryall 500e	LD
27-28	1477	2018	CLUB CAR	Carryall 1700 Gas	Cart	LD	OSF		CLUB CAR	Carryall 1700e	LD
27-28	1479	2018	FORD	Transit T-350 15 Passenger	Van - Specialty	MD	MSP-Youth/ Heritage Park	2024	Lightning eMotors	T350e	MD
27-28	1499	2019	CLUB CAR	Transporter 4 W/Cargo Box	Cart	LD	Civic Center		CLUB CAR	Transporter Electric	LD
27-28	1501, 1502, 1503, 1505	2019	CLUB CAR	Carryall 700	Cart	LD	OSF		CLUB CAR	Carryall 700e	LD

Appendix C – Irvine Community Places of Interest

Community Centers and Parks		
Location Type	**Location Name**	**Location Address**
Park	Sweet Shade Neighborhood Park	15 Sweet Shade, Irvine, CA 92606
Park	Colonel Bill Barber Marine Corps Memorial Park	4 Civic Center Plaza, Irvine, CA 92606
Community Center	Portola Springs Community Center	900 Tomato Springs, Irvine, CA 92618
Community Center	Los Olivos Community Center	101 Alfonso, Irvine, CA 92603
Community Center	Turtle Rock Community Center	1 Sunnyhill, Irvine, CA 92603
Community Center	Las Lomas Community Center	10 Federation Way, Irvine, CA 92603
Community Center	Quail Hill Community Center	39 Shady Canyon Dr, Irvine, CA 92603
Community Center	University Community Center	1 Beech Tree Lane, Irvine, CA 92612
Senior Community Center	Rancho Senior Center	3 Ethel Coplen Way, Irvine, CA 92612
Community Center	Deerfield Community Center	55 Deerwood W, Irvine, CA 92604
Senior Community Center	Lakeview Senior Center	20 Lake Rd, Irvine, CA 92604
Community Center	Cypress Community Center	255 Visions, Irvine, 92620
Community Center	Trabuco Center	5701 Trabuco Rd, Irvine, CA 92620
Community Center	Woodbury Community Center	130 Sanctuary, Irvine, CA 92620
Community Center	Heritage Community Center	14301 Yale Ave., Irvine, CA 92604
Community Center	Harvard Community Center	14701 Harvard Ave, Irvine, CA 92606
MUD Housing in Disadvantaged Community - ZIP Code: 92618		
Title 1 Schools		
Location Type	**Location Name**	**Location Address**
Elementary School	Culverdale	2 Paseo Westpark, Irvine, CA 92614
Elementary School	Cypress Village	355 Rush Lily, Irvine, CA 92620
Elementary School	Deerfield	2 Deerfield Ave, Irvine, CA 92604
Elementary School	Eastshore	155 Eastshore, Irvine, CA 92604
Elementary School	Greentree	4200 Manzanita St, Irvine, CA 92604
Elementary School	Meadow Park	50 Blue Lake S, Irvine, CA 92614
Elementary School	Northwood	28 Carson, Irvine, CA 92620
Elementary School	Oak Creek	1 Dovecreek, Irvine, CA 92618
Elementary School	Springbrook	655 Springbrook N, Irvine, CA 92614
Elementary School	University Park	4572 Sandburg Way, Irvine, CA 92612
Elementary School	Westpark	25 San Carlo, Irvine, CA 92614
K-8 School	Cadence Park	750 Benchmark, Irvine, CA 92618
K-8 School	Plaza Vista	670 Paseo Westpark, Irvine, CA 92606
Middle School	Lakeside	3 Lemongrass, Irvine, CA 92604
Middle School	South Lake	655 W Yale Loop, Irvine, CA 92614
Middle School	Venado	4 Deerfield Ave, Irvine, CA 92604

High Schools		
Location Type	**Location Name**	**Location Address**
High School	Northwood	4515 Portola Pkwy, Irvine, CA 92620
High School	Portola	1001 Cadence, Irvine, CA 92618
High School	Irvine	4321 Walnut Ave, Irvine, CA 92604
High School	Woodbridge	2 Meadowbrook, Irvine, CA 92604
High School	University	4771 Campus Dr, Irvine, CA 92612

Center for Sustainable Energy®

One mission — DECARBONIZE.®

The Center for Sustainable Energy® (CSE) is an independent nonprofit that is transforming markets for clean transportation and distributed energy through software-enabled program design and administration. CSE has administered over $2 billion in incentive programs for governments, utilities and the private sector across the U.S.